A ROBUST SYMMETRICAL NUMBER SYSTEM WITH GRAY CODE PROPERTIES FOR APPLICATIONS IN SIGNAL PROCESSING

Ilker Aydin Akin-Lieutenant Junior Grade, Turkish Navy
B.S., Turkish Naval Academy, 1991
Master of Science in Systems Engineering-September 1997
Advisor: Phillip Pace, Department of Electrical and Computer Engineering
Second Reader: David Styer, Department of Mathematics, University of Cincinnati

A new symmetrical number system with applications in parallel signal processing is investigated. The Robust Symmetrical Number System (RSNS) is a modular system in which the integer values within each modulus, when considered together, change one at a time at the next position (Gray code properties). Although the observed dynamic range of the RSNS is somewhat less than the optimum symmetrical number system, the Gray code properties make it particularly attractive for folding analog-to-digital converters. With the RSNS, the encoding errors (due to comparator thresholds not being crossed simultaneously) are eliminated, as is the need for the corresponding interpolation signal processing (reduced complexity). Computer generated data is used to help determine the properties of the RSNS. These properties include the largest dynamic range (number of distinct consecutive vectors), and the position of the largest dynamic range within the system. The position of the maximum unambiguous dynamic range is also quantified. Least squares analysis of 2 and 3 moduli systems is used to formulate closed-form expressions for the dynamic range. To compare the advantages of the RSNS with previously published results, the transfer function of a 3-channel RSNS folding analog-to-digital converter architecture *($m_1 = 3$, $m_2 = 4$,* and *$m_3 = 5$)* is numerically evaluated using SPICE.

PRACTICAL IMPLEMENTATION OF THE HARD SWITCHED BUCK CHOPPER

Kirk D. Allen-Lieutenant Commander, United States Navy
B.S., Texas A&M University, 1982
Master of Science in Electrical Engineering-March 1997
Advisor: Robert W. Ashton, Department of Electrical and Computer Engineering
Second Reader: John G. Ciezki, Department of Electrical and Computer Engineering

As the Navy progresses into the twenty-first century, new concepts in shipboard electrical power management are being explored. One area of significant interest to the Navy is utilization of DC electrical distribution systems rather than traditional AC distribution systems. The DC Zonal Electrical Distribution System is a prime candidate for direct application to modem power distribution. This system employs solid-state conversion devices to supply ships loads from one of two high-voltage DC busses. One such device, a buck chopper, is the focus of this thesis. In order to validate this proposed architecture, the startup and transient performance of these choppers must be explored. The buck chopper incorporates a control technique which employs both voltage and current feedback in conjunction with feed-forward. Specific advantages of this control technique with the buck chopper circuit include power source perturbation rejection, fast dynamic response to both load and source voltage changes and a house curve for parallel buck chopper operation. The design will include both over-current and thermal protection in order to prevent circuit component damage. The focus of this thesis is to validate the predicted operation of this control technique and to verify circuit performance.

INTEGRATED OPTICAL FIBER LATTICE ACCUMULATORS

Adam F. Atherton-Civilian
B.S., California State University, Fresno, 1988
Master of Science in Electrical Engineering-March 1997
Advisor: Phillip E. Pace, Department of Electrical and Computer Engineering
Second Reader: John P. Powers, Department of Electrical and Computer Engineering

Sigma-delta modulators track a signal by accumulating the error between an input signal and a feedback signal. The accumulated energy is amplitude analyzed by a comparator. The comparator output signal is fed back and subtracted from the

input signal. This thesis is primarily concerned with designing accumulators for inclusion in an optical sigma-delta modulator. Fiber lattice structures with optical amplifiers are used to perform the accumulation. Two fiber lattice structures are designed, modeled, tuned, tested, and characterized. The testing results for both models are plotted and tabulated. One result is that accumulation is inversely proportional to coupling ratio. Also, the optical gain necessary to drive either fiber lattice structure to a monotonically increasing response is identical. With less than 10 dB of optical gain, a wide range of accumulation rates are available. Initial integration of one fiber lattice structure into a first-order sigma-delta modulator is accomplished with results consistent with those from an ideal model. The design for a second-order sigma-delta modulator is developed, tested, and preliminary results shown.

POWER ELECTRONIC BUILDING BLOCK NETWORK SIMULATION TESTBED STABILITY CRITERIA AND HARDWARE VALIDATION STUDIES

Michael G. Badorf-Lieutenant, United States Navy
B.S., United States Naval Academy, 1990
Master of Science in Electrical Engineering-June 1997
Advisor: Robert W. Ashton, Department of Electrical and Computer Engineering
Second Reader: John G. Ciezki, Department of Electrical and Computer Engineering

Naval power distribution has principally used an AC network to supply loads. With the advent of new power electronic devices, the focus has shifted to employing a DC distribution system that eliminates large transformers and mechanical switching devices and enhances the survivability of the platform. The Power Electronic Building Block (PEBB) Network Simulation Testbed currently under construction at the Naval Postgraduate School is a study into the feasibility of such DC systems.

The objective of this thesis was to perform theoretical and simulation-based analysis to establish quantitative criteria for PEBB Testbed stability. These criteria were then used to develop a set of hardware studies to investigate the interaction of components within the PEBB Testbed. Finally, the hardware studies were utilized to verify PEBB Testbed performance.

Principal conclusions of this research included that the PEBB Test bed demonstrated stability under all simulated loading conditions. Follow-on testing of the PEBB Testbed confirmed that the simulations correlated well with hardware implementation. In addition, the hardware validation studies revealed that switching harmonics had a considerable effect on the system output.

DENOISING OF OCEAN ACOUSTIC SIGNALS USING WAVELET-BASED TECHNIQUES

Robert J. Barsanti, Jr.-Lieutenant Commander, United States Navy
B.S., Polytechnic Institute of New York, 1982
Master of Science in Electrical Engineering-December 1996
Master of Science in Engineering Acoustics-December 1996
Advisors: Monique P. Fargues, Department of Electrical and Computer Engineering
Ralph Hippenstiel, Department of Electrical and Computer Engineering

This thesis investigates the use of wavelets, wavelet packets, and cosine packet signal decompositions for the removal of noise from underwater acoustic signals. Several wavelet based denoising techniques are presented and their performances compared. Results from the comparisons are used to develop a wavelet-based denoising algorithm suitable for a wide variety of underwater acoustic transients. Performances of the denoising algorithm are compared to those of a short-time Wiener filter implementation and demonstrate that wavelet-based methods are a viable tool for the denoising of acoustic data.

WIRELESS COMMUNICATIONS FOR A MULTIPLE ROBOT SYSTEM

Alexander J. Bekas-Lieutenant, Hellenic Navy
B.S., Hellenic Naval Academy, 1988
Master of Science in Electrical Engineering-March 1997
Advisors: G. M. Lundy, Department of Computer Science
Xiaoping Yun, Department of Electrical and Computer Engineering
Second Reader: Yutaka Kanayama, Department of Computer Science

A multi-disciplinary research project is being undertaken at NPS to develop a semiautonomous robotic system to detect and clear land mines and Unexploded Ordnance (UXO). The robotic system under development consists of a land vehicle, an aerial vehicle, and a ground-based control station. Reliable communication between these three stations is needed. A traditional wire-based network requires that the vehicles be tethered and severely limits the mobility of the vehicles. A wireless Local Area Network (LAN) is proposed to provide communications between the control station and the vehicles.

The objective of this thesis was to develop the physical (hardware) and logical (software) architecture of a wireless LAN that accommodates the needs of the mine/UXO project. Through an analysis of wireless modulation techniques, a market survey of wireless devices, and a field testing of wireless devices, a wireless LAN was designed to meet the technological, performance, regulation, interference, and mobility requirements of the mine/UXO project. Finally, the wireless communication protocols and the development of an error-free application protocol (specified by a FSM model and implemented in ANSI C code using Windows socket network programming) completed the wireless LAN implementation.

UNCLASSIFIED FEASIBILITY OF REPLACING OR SUPPLEMENTING THE EA-6B SUPPORT JAMMING SYSTEM USING UAV BASED JAMMER(U)

Edwin J. Burns-Lieutenant, United States Navy
B.S., Iowa State University, 1989
Master of Science in Systems Engineering-September 1997
Advisor: Curtis D. Schleher, Information Warfare Academic Group
Second Reader: Donald v.Z. Wadsworth, Department of Electrical and Computer Engineering

(U) There are increasing demands by theater CINCS for EA-6B Electronic Attack aircraft to provide Stand-Off-Jamming support during peace operations, as well as to protect aircraft which have missions near and within hostile countries. To reduce some of the demands for the EA-6B, large-payload Unmanned Aerial Vehicles (UAVs) containing stand-off Electronic Attack packages are now feasible. This study analyzes the feasibility of replacing or supplementing the EA-6B support jamming system using a UAV based jammer. The Global Hawk UAV with the ALQ-99 Electronic Attack system are the base systems for this study. This added support along with Global Hawks increased connectivity, higher survivability, and long on station time would give the EA-6B added flexibility in its employment against advanced radar and SAM systems. Global Hawk would still perform its primary mission of collecting airborne imagery, when not required to support the Suppression of Enemy Air Defenses. In order to determine the appropriate Concept of Operations for Global Hawk as a Stand-Off-Jammer, this study includes a threat analysis, and a determination of required airframe and electrical modifications.

CLASSIFICATION OF UNDERWATER SIGNALS USING A BACK-PROPAGATION NEURAL NETWORK
Richard Campbell Bennett, Jr.-Lieutenant, United States Navy
B.E., State University of New York Maritime College, 1987
Master of Science in Electrical Engineering-June 1997
Advisors: Monique P. Fargues, Department of Electrical and Computer Engineering
Roberto Cristi, Department of Electrical and Computer Engineering

This thesis examines a number of underwater acoustic signals and the problem of classifying these signals using a back-propagation neural network. The neural network classifies the signals based upon features extracted from the original signals. The effect on classification by using an adaptive line enhancer for noise reduction is explored. Two feature extraction methods have been implemented: modeling by an autoregressive technique using the reduced-rank covariance method, and the discrete wavelet transformation. Both orthonormal and nonorthonormal transforms are considered in this study.

THE DESIGN, IMPLEMENTATION AND TESTING OF AN UNINTERRUPTIBLE POWER SUPPLY FOR THE AN/MRC-142 UHF RADIO SYSTEM
William E. Callahan-Captain, United States Marine Corps
B.S., Virginia Military Institute, 1987
Master of Science in Electrical Engineering-March 1997
Advisor: Sherif N. Michael, Department of Electrical and Computer Engineering
Second Reader: Robert W. Ashton, Department of Electrical and Computer Engineering

The design of an uninterruptible power supply (UPS) for the United States Marine Corps AN/MRC-142 Ultra High Frequency Radio system is presented. The components of the AN/MRC-142 communications system are analyzed with regard to their power requirements so that the nature of the system's shortcoming can be well understood. The fundamentals of electrical power design and distribution, and basic UPS topologies are presented. Five design alternatives that provide a solution to the identified system shortcoming are presented, tested, and evaluated. The paper concludes with a recommendation to the Marine Corps Systems Command for the UPS alternative that best provides uninterruptible power for the AN/MRC-142.

A FUTURE SPACE INTELLIGENCE ARCHITECTURE (U)
Michael J. Carlan-Lieutenant, United States Navy
B.S., University of South Carolina, 1992
Master of Science in Space Systems Operations-September 1997
Advisor: Herschel H. Loomis, Jr., Department of Electrical and Computer Engineering
Second Reader: Vicente C. Garcia, National Security Agency Cryptologic Chair

The existing satellite intelligence architecture is an aggregation of individual systems developed during the Cold War era by separate organizations and for different purposes. Their current operation reflects the singularity of their origins, designs, functions, support infrastructures, organizational affiliations, management philosophies, and requirements baselines. Planned systems represent a major initiative to achieve a more coherent functionality and to redress capability shortfalls. However, numerous factors present themselves that, in the future, may require multiple intelligence (Multi-NT) and multiple function (Multi-function) capable architectures to satisfy the needs of national users and operational commanders.

Developing the rationale, system attributes, and requirements for a Future Space Intelligence Architecture (FSIA) and determining the correct mix of reconnaissance, surveillance, and intelligence systems that satisfy national and military requirements is the objective of this thesis.

A STUDY OF VIDEO TELECONFERENCING TRAFFIC ON A TCP/IP NETWORK

Harlan A. Carvey-Captain, United States Marine Corps
B.S., Virginia Military Institute, 1989
Master of Science in Electrical Engineering-March 1997
Advisor: Murali Tummala, Department of Electrical and Computer Engineering
Second Reader: Herschel H. Loomis, Jr., Department of Electrical and Computer Engineering

In this thesis the nature of variable bit rate (VBR) traffic, as generated by a video teleconferencing (VTC) application, in an Ethernet environment is studied. Analysis of the data retrieved from a testbed using metrics such as the rescaled adjusted range statistic, variance-time curve, and index of dispersion for counts illustrate the self-similar nature of traffic generated by a video teleconferencing application. This information is useful in formulating accurate models to support the various classes of traffic that will dominate the broadband ISDN (B-ISDN or ATM) infrastructure and in developing adequate access control mechanisms for these classes of traffic. The future of wide-area networking will see Ethernet LANs populating the access points of ATM WANs, thus making use of the ATM transport mechanism for wide-area communications. This thesis reports on work pertaining only to the traffic offered by the Ethernet LAN.

Java and the Simple Network Management Protocol (SNMP) provide the means with which to construct tools for gathering and simulating VTC traffic. Java applets were written to measure and simulate VTC traffic.

ACOUSTIC MOTION ESTIMATION AND CONTROL FOR AUTONOMOUS UNDERWATER VEHICLES

Hakki Çelebioglu-Lieutenant Junior Grade, Turkish Navy
B.S., Turkish Naval Academy, 1991
Master of Science in Electrical Engineering-June 1997
Advisor: Roberto Cristi, Department of Electrical and Computer Engineering
Second Reader: Xiaoping Yun, Department of Electrical and Computer Engineering

An integrated model of acoustic motion estimation and control is presented. The control system is designed on the basis of the definitions of suitable Lyapunov functions for the different maneuvers in approaching a target. These functions allow the navigation and maneuvering tasks to be performed in a two-layered hierarchical architecture for closed-loop control. The motion estimation algorithm uses pencil beam profiling sonar range and bearing information. The operating environment is modeled with a suitable three-dimensional potential function and its gradient which forms an attractive field. This algorithm provides satisfactory performance for autonomous navigation and obstacle avoidance.

The applicability and robustness of this model are demonstrated with both actual test data obtained with the NPS *Phoenix* submersible and computer generated simulation data. The results show the effectiveness of the combined estimation and control model.

INTERACTIVE TOOLS FOR SOUND SIGNAL ANALYSIS/SYNTHESIS BASED ON A SINUSOIDAL REPRESENTATION

Ming-Fei Chuang-Lieutenant, Republic of China Navy
B.S., Chung-Chang Institute of Technology, 1992
Master of Science in Engineering Acoustics-March 1997
Advisor: Charles W. Therrien, Department of Electrical and Computer Engineering
Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

This thesis develops a series of programs that implement the sinusoidal representation model for speech and sound waveform analysis and synthesis. This sinusoidal representation model can also be used for a variety of sound signal transformations such as time-scale modification and frequency scaling. The above sound analysis/synthesis sinusoidal representations and transformations were developed as two interactive tools with Graphical User Interface (GUI) using MATLAB. In addition, an interactive tool for signal frequency component editing based on the sinusoidal model is also presented in this thesis.

A HIGH POWER MICROWAVE APPLICATION FOR INFORMATION OPERATIONS (U)

Kurt Steven Collom-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1985
Aerospace Engineering, May 1985
Master of Science in Systems Engineering-September 1997
and
James Edward Craig-Captain, United States Army
B.S., Texas A&M University, 1986
Physics, December 1986
Master of Science in Systems Engineering-September 1997
Advisors: Captain J.R. Powell, Information Warfare Academic Group
M.A. Morgan, Department of Electrical and Computer Engineering

(U) This thesis documents the requirement, concept, and validation process for the feasibility demonstration of a high power microwave application for Information Operations. Information Warfare (IW) and Information Operations (IO) are about providing the commander or decision-maker with options. Information Attack provides new courses-of-action for the commander when pursuing his mission objectives and gives him unique capabilities to attack the adversary in previously unimaginable ways. In order to procure any new weapons system, there must be a valid requirement for the system. In some cases, if the technology already exists, or if the system under consideration is an extension of an existing requirement, the new system concept may be validated by a feasibility demonstration. Supporting documents to this thesis provide summaries of testing conducted to demonstrate and quantify the potential effectiveness of the application.

PROPAGATION OF VERTICALLY POLARIZED
WAVES OVER ROUGH OCEAN SURFACES

Jeffrey G. Conrad-Lieutenant Commander, Canadian Navy,
B.S., Dalhousie University, 1985
Master of Science in Electrical Engineering-June 1997
Advisor: Ramakrishna Janaswamy, Department of Electrical and Computer Engineering
Second Reader: David C. Jenn, Department of Electrical and Computer Engineering

The problem of propagation of vertically polarized radiowaves in an inhomogeneous atmosphere and over rough ocean surfaces is solved using the parabolic equation method. The solution of the parabolic equation is accomplished through the use of the Fourier split-step algorithm. Formulation of the equations is based upon (i) recognizing that the Fourier kernels of the transform equations in the split step algorithm represent planes waves and (ii) compensating for the effects of rough ocean surfaces by using a rough surface reduction factor directly in the spectral domain. To accomplish this a redefinition of the Fourier transform pair is done to ensure mathematical consistency. The formulation also incorporates the first and second derivatives of the refractivity index to accommodate steep gradients in the refractivity profile. Hanning windows are used in both the spatial and wavenumber domains to contain computational requirements. The effects on propagation by varying parameters such as wave heights, computational domain ceilings, frequency, and step size are investigated.

PROPAGATION OF VERTICALLY POLARIZED
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DATABASE ACCESS FROM THE WEB
A.S. Dean-Lieutenant Commander, United States Navy
B.B.A., University of Texas, 1982
Master of Science in Computer Science-March 1997
Advisors: C. Thomas Wu, Department of Computer Science
Monique P. Fargues, Department of Electrical and Computer Engineering

Determining the best method for granting World Wide Web (Web) users access to remote relational databases is difficult. Choosing the best supporting Web/database link method for implementation requires an in-depth understanding of the methods available and the relationship between the link designer's goals and the underlying issues of Performance and Functionality, Cost, Development Time and Ease, Serviceability, Flexibility and Openness, Security, State, and Session.

This thesis examined existing methods for enabling Web-client access to remote relational databases and found that most fall within the general categories of Common Gateway Interface scripts, Server Application Programming Interfaces, Web-enabled Database Management Systems exporting query results in Hypertext Markup language, and independent client-based processes such as Java applets. To determine the best database access category we compared each one to the underlying link issues and conducted a case study for the IEEE Signal Processing Society.

The results of this thesis are: (1) a taxonomy of existing Web/database linking methods, (2) a thorough listing and examination of the underlying issues as they relate to each link method, and (3) recommendation and specification of the proper link method and hardware/software support system for the case study linkage problem.

IMPROVING DIGITAL SIGNAL PROCESSING CAPABILITIES OF THE AN/SRS-1 (V) SIGNAL DETECTION AND DIRECTION FINDING SET (U)
Bruce A. Dickey-Lieutenant, United States Navy
B.S. Civil Engineering, North Carolina State University, 1989
Master of Science in Electrical Engineering-June 1997
Advisors: Vicente C. Garcia Jr., National Security Agency Cryptologic Chair
Chiang Tom, Space and Naval Warfare Systems Center-San Diego

CLASSIFIED ABSTRACT

PREDISTORTION OF QUADRATURE AMPLITUDE MODULATION SIGNALS USING VOLTERRA SERIES APPROXIMATION
Michael T. Donovan-Major, United States Army
B.S., Purdue University, 1984
Master of Science in Electrical Engineering-December 1996
Advisor: Murali Tumala, Department of Electrical and Computer Engineering
Second Reader: Charles W. Therrien, Department of Electrical and Computer Engineering

Modern digital communication systems are being called upon to move ever increasing amounts of information over decreasingly available bandwidth. This requires that communication systems employ bandwidth-efficient modulation schemes

to conserve bandwidth while moving the information at higher data rates. A major stumbling block to using higher order modulation schemes in long-haul communication is the distortion caused by high power amplifiers. These high power amplifiers are required to amplify the signal power to a level that will allow distant receivers to correctly demodulate and decode the information. The distortion caused by the high power amplifiers can render a modulation scheme unusable due to the high symbol error rates which result from the extensive skewing of the modulation scheme's signal constellation. This thesis details a predistortion technique using Volterra series approximation techniques to model the inverse of the high power amplifier's distortion characteristics. A 64 Quadrature Amplitude Modulation (64-QAM) system incorporating a predistorter is used to demonstrate the ability to achieve acceptable bit error rates. The implementation of the inverse model and the communication system is performed in MATLAB. The results show the viability of predistortion of digital data to allow the higher order modulation schemes to be incorporated into communication schemes, increasing the overall data rate while conserving bandwidth.

TRACKING MULTIPLE TARGETS IN CLUTTERED ENVIRONMENTS WITH THE PROBABILISTIC MULTI-HYPOTHESIS TRACKING FILTER

Darin T. Dunham-Captain, United States Marine Corps
B.S., Carnegie Mellon University, 1991
Master of Science in Electrical Engineering-March 1997
Advisor: Robert G. Hutchins, Department of Electrical and Computer Engineering
Second Reader: Harold A. Titus, Department of Electrical and Computer Engineering

Tracking multiple targets in a cluttered environment is extremely difficult. Traditional approaches generally use simple techniques that combine gating with some form of nearest neighbor association to reduce the effects of clutter. When clutter densities increase, these traditional algorithms fail to perform well. To counter this problem, the multi-hypothesis tracking (MHT) algorithm was developed. This approach enumerates almost every conceivable combination of measurements to determine the most likely tracks. This process quickly becomes very complex and requires vast amounts of memory in order to store all of the possible tracks.

To avoid this complexity, more sophisticated single hypothesis data association techniques have been developed, such as the probabilistic data association filter (PDAF). These algorithms have enjoyed some success, but do not take advantage of future data to help clarify ambiguous situations.

On the other hand, the probabilistic multi-hypothesis tracking (PMHT) algorithm, proposed by Streit and Luginbuhl in 1995, attempts to use the best aspects of the MHT and the PDAF. In the PMHT, data is processed in batches, thereby using information from before and after each measurement to determine the likelihood of each measurement-to-track association. Furthermore, like the PDAF, it does not attempt to make hard assignments or enumerate all possible combinations, but instead associates each measurement with each track based upon its probability of association.

Actual performance and initialization of the PMHT algorithm in the presence of significant clutter has not been adequately researched. This study focuses on the performance of the PMHT algorithm in dense clutter and the initialization thereof. In addition, the effectiveness of measurement attribute data is analyzed, especially as it relates to algorithm initialization. Further, it compares the performance of this algorithm to the nearest neighbor, MHT, and PDAF.

DESIGN AND SIMULATION OF A LOW TEMPERATURE GaAs MESFET

Douglas C. Eskins-Lieutenant, United States Navy
B.S.E.E, University of Illinois, 1990
Master of Science in Electrical Engineering-June 1997
Advisor: Todd Weatherford, Department of Electrical and Computer Engineering
Second Reader: Ron Pieper, Department of Electrical and Computer Engineering

With the need for fast, low power, radiation hardened electronics growing, especially in space based systems, GaAs has become an increasingly important technology. The Metal Semiconductor Field Effect Transistor (MESFET) is one of the most commonly used elements in GaAs Systems, and accurate modeling of its properties is essential to development of GaAs technology. The problem addressed is how to predict MESFET parameters based upon semiconductor-level proper-

ties such as doping levels and junction placement. This thesis develops a semiconductor level model of a MESFET and uses it to evaluate various MESFET designs. Specifically, the Vitesse standard MESFET will be simulated and comparisons made with designs involving uniform P layers and Low Temperature (LT) grown GaAs layers. Such designs are thought to provide desirable properties with regard to radiation tolerance, especially single event upsets (SEU's). Computer simulations are run using both MATLAB and SILVACO software and compared against measured device parameters. Overall modeling suggests ways that the standard Vitesse MESFET process could be modified to incorporate these design changes, yet maintain standard device threshold voltage and current parameters. Furthermore, the design methodologies developed could be applied to a wider class of GaAs devices and aid in the overall development of this increasingly important technology.

AN ANALYSIS OF THE IIR AND FIR WIENER FILTERS WITH APPLICATIONS TO UNDERWATER ACOUSTICS
Natanael Ruiz Fontes-Lieutenant Commander, Brazilian Navy
B.S., University of Sao Paulo, 1988
Master of Science in Electrical Engineering-June 1997
Master of Science in Engineering Acoustics-June 1997
Advisor: Charles W. Therrien, Department of Electrical and Computer Engineering
Second Reader: Anthony A. Atchley, Department of Physics

A detailed analysis of the performance the Wiener optimal filter for estimating a signal in additive noise is carried out. A first order AR model is assumed for both the signal and noise. Both IIR and FIR forms of the filter are considered and expressions are derived for the processing gain, mean-square error, and signal distortion. These measures are plotted as a function of the model parameters. This analysis motivates a generalized form of the Wiener filter, which can improve the signal distortion. An analysis of this more general filter is then carried out. A practical noise removal algorithm based on short-time filtering using the generalized filter is also described and results of applying the algorithm to some typical underwater acoustic data are presented.

A 3-CHANNEL 14-BIT OPTIMUM SYMMETRICAL NUMBER SYSTEM (SNS) WIDEBAND DIGITAL ANTENNA: ANALYSIS OF THE ELECTRO-OPTIC SAMPLING FRONT END
Kevin D. Foster-Lieutenant, United States Navy
BET, State University College at Buffalo, 1986
Master of Science in Electrical Engineering-September 1997
Advisor: Phillip E. Pace, Department of Electrical and Computer Engineering
Second Reader: John P. Powers, Department of Electrical and Computer Engineering

Space considerations onboard naval surface ships frequently preclude adequate separation between high frequency (HF) transmit antennas and HF receive only antennas. As a result, high power shipboard emanations (for example, Link-11) interfere with low power signals of interest operating within the same frequency band. Symmetrical-Number-System (SNS) digital antennas provide high-resolution direct digitization of wideband signals with excellent in-band signal-rejection characteristics, which makes them ideal for operating within high RF environments. This thesis describes the design, construction, testing, and analysis of the optical electronics at the front end of a prototype optimum SNS digital antenna with a desired accuracy of 14 bits and a bandwidth of 2.5 MHz. The digital antenna utilizes pulsed laser sampling in conjunction with a parallel configuration of Mach-Zehnder interferometers which provide superior bandwidth and isolation performance over electronic sampling mechanisms. The interferometer folded output signal is in accordance with the optimum SNS which yields the maximum amount of information from a folding waveform. The theory and experimental performance of the optical subsystem and the analog electronics subsystem is presented, and the total system performance is evaluated. A summary of results and a conclusion with recommendations for improvements to follow-on systems is also discussed.

DESIGN OF AN ALGORITHM FOR MINIMIZING LORAN-C TIME DIFFERENCE ERROR

Frederick M. France, Jr.-Lieutenant, United States Navy
B.S.E.E., University of Southern California, 1987
Master of Science in Electrical Engineering-September 1997
Electrical Engineer-September 1997
Advisors: Murali Tummala, Department of Electrical and Computer Engineering
Roberto Cristi, Department of Electrical and Computer Engineering

The United States Coast Guard (USCG) is in the process of upgrading the hardware of the Loran-C Radionavigation System Control System. As part of this effort, the Computer-Assisted Loran-C Controller (CALOC), is also in need of improvement. CALOC performs four tasks: abnormality detection, time difference control, recordkeeping, and blink control. The work reported in this thesis focuses on time difference control. In many instances, CALOC does not accurately control the time difference error (TDE) within the established USCG control procedures. Two new algorithms are proposed here to control TDE more effectively: a proportional-integral-derivative (PID) controller and a Kalman filter. Actual TDE data recorded at three different master stations covering five Loran-C chains is used to evaluate the performance of the proposed controllers. The PID controller shows a substantial improvement in control compared to CALOC, and the Kalman filter exhibits even better performance, based on preliminary results. This improvement in control correlates directly with an increase in both predictable accuracy and repeatable accuracy.

COMPARISON OF THE STEP FREQUENCY RADAR WITH THE CONVENTIONAL CONSTANT FREQUENCY RADARS

Dimitrios N. Geladakis-Major, Hellenic Army
B.S., Hellenic Military Academy, 1980
B.S.E.E., National Polytechnic University of Athens, 1986
Master of Science in Electrical Engineering-December 1996
Advisor: Gurnam Gill, Department of Electrical and Computer Engineering
Second Reader: Phillip Pace, Department of Electrical and Computer Engineering

In this thesis, the Step Frequency radar system is compared with the conventional Constant Frequency radar system. The two radar systems are separately analyzed and their analyses are followed by a comparison which is mainly based upon their effectiveness to detect moving targets in clutter. The step frequency waveform consists of a series of pulses whose pulse width is constant and whose carrier frequency is linearly increased from pulse to pulse in steps. As compared to the conventional constant frequency radar waveforms, the step frequency waveform can achieve high range resolution while still retaining the advantages of lower instantaneous receiver bandwidth and lower analog-to-digital sampling rate at the expense, however, of more complex signal processing.

DYNAMIC CONTROL OF A VEHICLE WITH TWO INDEPENDENT WHEELS

Douglas R. Gerrard-Lieutenant, United States Navy
B.S., University of Missouri, 1990
Master of Science in Electrical Engineering-September 1997
Advisor: Xiaoping Yun, Department of Electrical and Computer Engineering
Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

The feedback control and modeling of a mobile robot with two wheels that are independently steerable and drivable is studied. Two-wheel steer vehicles increase their maneuverability when both wheels are drivable and therefore increases their performance in confined spaces. A dynamic feedback control algorithm is developed, which enables the vehicle to move from any initial configuration (position and orientation) to any final configuration. Simulation results are presented to verify the independent control of the two position variables and the orientation variable. A comparison with a two-wheel steering and one wheel drive vehicle shows that driving both wheels increases performance and maneuverability.

IMPLEMENTING CLOSED-LOOP CONTROL ALGORITHMS FOR DC-TO-DC CONVERTERS AND ARCP INVERTERS USING THE UNIVERSAL CONTROLLER

Ronald J. Hanson-Lieutenant, United States Navy
B.S., University of North Dakota, 1988
Master of Science in Electrical Engineering-June 1997
Advisor: John G. Ciezki, Department of Electrical and Computer Engineering
Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

The objective of this thesis is to investigate the use of the Universal Controller to control the DC-to-DC power converter and the Auxiliary Resonant Commutated Pole (ARCP) power inverter. These power electronic devices are central to the development of a DC Zonal Electric Distribution System (DC ZEDS) that is scheduled for application in the twenty-first century surface combatant (SC-21). The development of appropriate closed-loop controls is a key element to this design process. The Universal Controller is a digital controller that was developed by personnel at the Naval Surface Warfare Center (NSWC), Annapolis, Maryland. The basic operation and control of the DC-to-DC buck converter and the ARCP inverter are described, with emphasis placed on the advantages of DSP control. A complete investigation of the hardware that comprises the controller and how to program the controller to implement closed-loop control is undertaken.

Previous studies have developed control algorithms that have been tested through simulation and analog hardware. In this research endeavor these control algorithms, particularly the one relevant to the DC-to-DC converter, are implemented using the Universal Controller to validate operations. Finally, a flow path for implementing the closed-loop control of the ARCP unit is discussed and recommendations for improvements in future designs are outlined.

THE MACH-ZEHNDER COUPLER

Maryanne Paap Heinbaugh-Lieutenant, United States Navy
B.A., University of Washington, 1986
Master of Science in Electrical Engineering-March 1997
Advisors: John Powers, Department of Electrical and Computer Engineering
Tri Ha, Department of Electrical and Computer Engineering

The Naval Postgraduate School (NPS) is currently researching the potential for and feasibility of an optical signal demultiplexer based on the Mach-Zehnder coupler. The coupler will be capable of discriminating between *M* different CSK signals employing *M* Hadamard codes. This thesis involves the examination of a single Mach-Zehnder coupler that operates at 100 Mbps and specifically addresses the mathematical analysis of how it operates, the physical components necessary to build and test a Mach-Zehnder coupler, and the performance of the Mach-Zehnder coupler.

IMPLEMENTATION OF NARROWBAND SOUND PRESSURE LEVEL ESTIMATION ALGORITHM IN A PERSONAL COMPUTER ENVIRONMENT

Eric R. Horning-Lieutenant, United States Navy,
B.S., Cornell University, 1990
Master of Science in Electrical Engineering-September 1997
Advisor: Murali Tummala, Department of Electrical and Computer Engineering
Second Reader: Michael Shields, Department of Electrical and Computer Engineering

This thesis implements the narrowband sound pressure level (SPL) estimation algorithm of the Automated Quick Look (AQL) system in a personal computer environment. The reengineered algorithm will act as a module of the proposed Beartrap Post-Mission Processing System (BPMPS). This new integrated system is designed to replace the current array of diverse processing systems that collectively serve as the post mission analysis system for Beartrap missions. Windows 95 is used as the operating environment and Microsoft Visual C++ as the implementation language. Capitalizing on the features of the chosen operating environment, this program provides the operator with the ability to analyze data from multiple sonobuoys and tonals associated with a submarine. The algorithm is tested using synthetic data based on two typical

scenarios. From the results obtained in this thesis, it can be said that the algorithm performs correctly, and the operator is provided with a flexible, user friendly analysis tool.

SYSTEM CONTROLLER HARDWARE AND EMBEDDED SOFTWARE FOR THE PETITE AMATEUR NAVY SATELLITE (PANSAT)

James Anthony Horning-Civilian
B.S.C.S., California Polytechnic - San Luis Obispo, 1989
Master of Science in Electrical Engineering-September 1997
Advisor: Rudolf Panholzer, Space Systems Academic Group
Second Reader: Randy L. Wight, Department of Electrical and Computer Engineering

This thesis documents the design of the hardware and embedded software of a digital computer that provides autonomous control of the PANSAT spacecraft. The system was designed for use during a two-year mission in a low earth orbit. The computer uses an Intel M8OCl86XL running at 7.3728 MHz, 512 kbytes of error-detection and correction RAM, 64 kbytes of ROM, and standard CMOS components to provide a general purpose microcomputer. The purpose of the computer is to control all subsystems of the spacecraft, perform analog-to-digital conversions, orchestrate duplicate hardware components to provide redundancy, and upload new software from a ground station. The hardware system was built on printed circuit boards which were manufactured by the Space System Academic Group of the Naval Postgraduate School and tested for proper operation. The embedded software was coded using 80186 Assembler and the C programming language, tested for proper operation, and placed into ROM as firmware.

THE APPLICATIONS IN MILITARY COMMUNICATIONS OF LOW AND MEDIUM EARTH ORBIT COMMERCIAL SATELLITE SYSTEMS

Ioannis Kakavas-Lieutenant, Hellenic Navy
B.Sc., Hellenic Naval Academy, 1989
Master of Science in Systems Engineering-September 1997
Advisors: Tri T. Ha, Department of Electrical and Computer Engineering
Vicente Garcia, National Security Agency Cryptologic Chair

At the dawn of the 21st century several Low and Medium Earth Orbit Commercial Satellite constellations will be operational and they will be able to provide high bandwidth Global Communications in voice, data, and multimedia services for mobile consumers and also “users in the move.” This research evolves as a continuation of previous studies (on Iridium, Globalstar, Teledesic, and Odyssey) and considers the ICO as well as the Teledesic and Global Broadcasting Services (GBS) systems in an effort to provide comprehensive model architecture. This model is desired to accommodate the narrowband, wideband, and broadcast requirements, respectively, of the U.S. MILSATCOM in addition to the communication needs of a model UN peacekeeping mission. The application of these systems to U.S. MILSATCOM coincides perfectly with the U.S. defense doctrine of a CONUS-based military with the capability of rapid global power projection to respond to crises throughout the global arena. Instead of investing heavily in new satellite systems, the U.S. military services can use the forthcoming commercial Low Earth Orbit (LEO) and Medium Earth Orbit (MEO) systems to meet the information requirements of tactical commanders.

THE USE OF NON-PARAMETRIC TRANSFER FUNCTION ESTIMATES TO PREDICT SUBMARINE HULL VIBRATIONS FROM NOISE SOURCE MEASUREMENTS (U)

Daphne Kapolka-Lieutenant Commander, United States Navy
B.A., University of Rhode Island, 1974
M.A., University of Chicago, 1976
M.S., Naval Postgraduate School, 1992
Doctor of Philosophy in Applied Physics-June 1997
Dissertation Chairman: Anthony A. Atchley, Department of Physics
Dissertation Supervisor: Robert M. Keolian, Department of Physics
Committee Members: Thomas J. Hofler, Department of Physics
Andrés Larraza, Department of Physics
Roberto Cristi, Department of Electrical and Computer Engineering
Joshua H. Gordis, Department of Mechanical Engineering

Fundamental and practical limitations in the ability of non-parametric transfer function estimates to predict submarine hull vibrations are investigated. In order to assess the prediction performance and to succeed with non-stationary transfer functions, new methods and terminology are developed. An expression is derived for the maximum fractional error due to leakage which can be expected for the prediction of a pure sinusoid. For the data analysis, Bendat and Piersol's techniques for multiple-correlated inputs are used to condition up to eight input signals. Data is analyzed in three stages of complexity. The first data analyzed is from a scale model submarine driven by shakers. The next data is from the *USS Dolphin*, a deep-diving diesel-electric submarine. Measurements were taken on the Dolphin both surfaced running on diesels and submerged running on battery. During the submerged runs a minimal engineering line-up was used to limit the number of active noise sources. The final data analyzed was obtained from the *USS Hartford*, a nuclear attack submarine while in a normal engineering line-up. Results discussed include the percentage of power remaining in the processed hull signals, the lack of sensitivity of the predictions to input order, and the practical limitations encountered.

A DIRECT SEQUENCE-CODE DIVISION MULTIPLE ACCESS/ DIFFERENTIAL PHASE-SHIFT KEYING (DS-CDMA/DPSK) MODEM DESIGN

Önder Kara-Lieutenant Junior Grade, Turkish Navy
B.S., Turkish Naval Academy, 1991
Master of Science in Electrical Engineering-March 1997
Advisors: Tri Ha, Department of Electrical and Computer Engineering
R. Clark Robertson, Department of Electrical and Computer Engineering

The development of a differential phase-shift keying (DPSK), direct sequence, spread spectrum modem is conducted for the purpose of creating a prototype design to be implemented in a multi-user environment. In this design, a maximal length sequence of 31 chips is used to spread the information data. The multi-user performance analysis is performed by using the Bit Error Rate (BER) test equipment (1645 Hewlett Packard data error analyzer). A multi-user interference cancellation circuit for two users is introduced, and measurements are performed to show its effectiveness.

The design itself encompasses the selection of components and demonstrates that the preliminary operational characteristics of a spread spectrum DPSK modem scheme for CDMA application can be achieved.

ELECTRONIC COUNTER-COUNTER MEASURES POTENTIAL OF A NONCOHERENT FH/MFSK COMMUNICATIONS SYSTEM UNDER CONDITIONS OF WORST CASE HOSTILE ELECTRONIC COUNTER MEASURES AND FADING CHANNELS

George Katsoulis-Lieutenant Junior Grade Hellenic Navy
B.S., Hellenic Naval Academy, 1989
Master of Science in Electrical Engineering-March 1997
Advisor: R. Clark Robertson, Department of Electrical and Computer Engineering
Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

This thesis investigates the performance degradation resulting from multitone interference of orthogonal, noncoherent frequency-hopped, M-ary frequency-shift keyed receivers (FH/MFSK) where the effect of thermal and other wideband noise is not neglected. The multiple, equal power jamming tones are assumed to correspond to some or all of the possible FH M-ary orthogonal signaling tones. Furthermore, the channel is modeled as a Ricean fading channel, a possibility precluded when thermal noise is neglected; and both the signaling tones and the multiple interference tones are assumed to be affected by channel fading. Both band and independent band multitone interference are considered. Performance is evaluated by obtaining a union bound on the probability of bit error, and receiver performance is compared with exact results for band multitone interference of a noncoherent FH/MFSK receiver under comparable circumstances. Except for the case of Rayleigh fading of the signal, the union bound is very tight for those cases that can be compared with exact results. The advantages of the union bound approach are twofold. First, the union bound approach yields a solution that is far more less computationally intensive than that obtained with the exact approach. Second, the union bound approach allows numerical results to be obtained for interference conditions that are not amenable to exact analysis, such as independent multitone interference of FH/MFSK.

WAVELET ANALYSIS OF INSTANTANEOUS CORRELATIONS WITH APPLICATION TO FREQUENCY HOPPED SIGNALS

Nabil Hamdy Shaker Khalil-Colonel, Egyptian Army
BSEE., Military Technical College, Cairo, Egypt, 1978
MSEE., Am-Shams University, Cairo, Egypt, 1991
Doctor of Philosophy in Electrical Engineering-September 1997
Advisors: Ralph Hippenstiel, Department of Electrical and Computer Engineering
Monique Fargues, Department of Electrical and Computer Engineering

Frequency hopped signals are widely used in various communication applications for their inherent security features. The demand, by civilian and governmental agencies, to intercept communication signals is increasing. The interception task can be summarized by detecting the signal's presence in additive noise, classifying the modulation type, estimating the control parameters, decoding the data, and decrypting the information content. This work addresses the merging of wavelet and correlation concepts to detect, classify, and estimate the parameters of frequency hopped signals. We address the interception problem in two ways. The first approach is based on a visual inspection of the wavelet surfaces generated from the instantaneous correlation function of the communication signal and leads to hop start/stop times estimates. In the second approach, we apply an energy-based processing scheme to estimate the hop start and stop times, the hop-scale pattern, and the hop frequency. Results show that frequency hopped signals can be identified at an SNR of 3 dB or 6 dB using visual inspection or an automated scheme, respectively.

A STUDY OF NATIONAL RECONNAISSANCE OFFICE'S (NRO) FUTURE COMMUNICATIONS ARCHITECTURE (U)

Won H. Kim-Lieutenant, United States Navy
B.S., University of Texas at Austin, 1986
Master of Sciences in Systems Technology-June 1997
Advisor: Dan C. Boger, Command, Control, and Communications Academic Group
William E. Clifton, Department of Electrical and Computer Engineering

The National Reconnaissance Office (NRO) has identified much higher data rate requirements for future national systems. The goal of this thesis is to provide a possible alternate solution that would utilize crosslink technology developed for the Iridium Mobile Satellite System combined with existing and emerging laser communications technology. In addition to many other advantages over RF communications, laser communications can fulfill the extremely high data requirements of the future NRO systems. This technology could be a part of a new satellite constellation that can provide single and double global coverage in Stage I and Stage II, respectfully, of the satellite constellation design.

UTILIZING WEB-BASED TECHNOLOGY TO DESIGN AND IMPLEMENT A CONFERENCE INFORMATION SYSTEM

Todd M. Kinney-Lieutenant Commander, United States Navy
B.A., Wabash College, 1986
Master of Science in Information Technology Management-September 1997
Advisors: Monique P. Fargues, Department of Electrical and Computer Engineering
Second Reader: Rex A. Buddenberg, Department of Systems Management

This thesis is a follow-on effort to work conducted by Michael Chalfant and Kevin Coats. The focus is the design and implementation of a web-based information system for the Asilomar Conference on Signals, Systems and Computers. This technical conference specializes in signal and image processing, communications, sensor systems, and computer hardware and software. Organized in collaboration with the Naval Postgraduate School, San Jose State University, and the IEEE Signal Processing Society, the Conference is conducted annually at the Asilomar Conference Facility in Pacific Grove, California. Initial project efforts concentrated on article submissions and system administration (i.e., database management). The article review process and overall implementation of the improved system is the focus of this thesis.

The objectives of this thesis are to: 1) analyze the article review process of the Asilomar Conference, 2) implement a World Wide Web (WWW) based article review process, and 3) implement the improved Asilomar Conference information system. Internet automation is accomplished via interactive WWW pages, created using Borland's Delphi as a programming tool, O'Reilly's WebSite as the web server, and Common Gateway Interface scripts as the mechanism for interactivity. This interactivity provides seamless global access to the Conference database and processes.

A DIRECT SEQUENCE-CODE DIVISION MULTIPLE ACCESS/ BINARY PHASE SHIFT KEYING (DS-CDMA/BPSK) MODEM DESIGN

Murat Kocakanat-Lieutenant Junior Grade, Turkish Navy
B.S., Turkish Naval Academy, 1991
Master of Science in Electrical Engineering-March 1997
Advisor: Tri Ha, Department of Electrical and Computer Engineering
R. Clark Robertson, Department of Electrical and Computer Engineering

In this thesis, the design of a direct sequence - code division multiple access/binary phase-shift keying (DS-CDMA/BPSK) modem is examined. In this prototype modem design, a short maximal length sequence of 31 chips is used to spread the information data. The design can be extended to longer codes to provide greater capacity and processing gain.

The hardware used in the functional realization of a working design is also discussed, and the preliminary operational characteristics of a spread spectrum BPSK modem are achieved. The multi-user performance analysis is conducted using

Bit Error Rate (BER) test equipment (HP1645A). The development of the final version of the modem operating at radio **f**requency (RF) is not conducted, but proof of concept is provided.

THE DESIGN OF THE RADIO FREQUENCY (RF) SUBSYSTEM PRINTED CIRCUIT BOARDS FOR THE PETITE AMATEUR NAVY SATELLITE (PANSAT)
Carl Andrew Lahti-Lieutenant, United States NaRy
B.S.S.E., United States Naval Academy, 1989
Master of Science in Electrical Engineering-June 1997
Electrical Engineer-June 1997
Advisors: Randy Borchardt, Department of Electrical and Computer Engineering
Rudolf Panholzer, Space Systems Academic Group

The Petite Amateur Navy Satellite (PANSAT) is a small digital communication satellite being developed by the Space Systems Academic Group and the Naval Postgraduate School. This thesis describes the layout of the three final flight printed circuit boards for the radio frequency (RF) subsystem for PANSAT. The circuits and layouts are documented in detail. A link analysis is performed to verify system design and a power budget provided for integration with other satellite systems. Printed circuit board design fundamentals and high frequency printed circuit board construction techniques are also described.

EVALUATION OF LAYOUT TECHNIQUES FOR RADIATION TOLERANT BULK CMOS INTEGRATED CIRCUITS
Andrew S. Lambley-Lieutenant, United States Navy
B.S., Auburn University, 1989
Master of Science in Electrical Engineering-September 1997
Advisor: Douglas J. Fouts, Department of Electrical and Computer Engineering
Second Reader: Todd Weatherford, Department of Electrical and Computer Engineering

Over the past seven years, the number of U.S. companies producing radiation-hardened (rad-hard) devices has dropped by 80%. National security dictates that we must maintain a domestic ability to produce rad-hard devices for use in space-borne and strategic systems. This research evaluates Integrated Circuit (IC) layout techniques for bulk CMOS processes that attempt to compensate for the effects of long-term exposure of the semiconductor devices to ionizing radiation. If successful, radiation-tolerant components could be manufactured without special fabrication equipment or costly circuit redesign. In addition to ensuring a domestic space-worthy electronics manufacturing capability, the utilization of standard fabrication processes could make the cost of producing rad-tolerant parts dramatically lower.

THE ANALYSIS OF INTERCONNECTED, HIGH-POWER DC-DC CONVERTERS FOR DC ZONAL ELECTRICAL DISTRIBUTION
Thomas Lucian Langlois-Captain, United States Marine Corps
B.S., University of Texas at Austin, 1987
Master of Science in Electrical Engineering-June 1997
Advisor: J. G. Ciezki, Department of Electrical and Computer Engineering
Second Reader: R. W. Ashton, Department of Electrical and Computer Engineering

As the United States Navy progresses into the twenty-first century, new concepts in shipboard electrical power management are being explored. One area of significant interest to the Navy is utilization of a DC Zonal Electrical Distribution System (DC-ZEDS) rather than a traditional AC distribution system. This system employs a network of solid-state power conversion devices to supply shipboard electrical loads from two or more high-voltage DC busses. The interconnection of these power converters stimulates several phenomenological questions and motivates multiple areas for study. Of key interest include interconnection dynamics through transmission lines and how the individual power sections of a DC-ZEDS

architecture react under real-world load stresses. The focus of this thesis is to use the Power Electronic Building Block Network Testbed at the Naval Postgraduate School to examine the effects **o**f line inductance and step changes in load on interconnected DC-DC converters. The findings of this research effort indicate that a system of networked buck converters can successfully operate in a DC-ZEDS architecture. In particular, buck converters were found to operate stably and were found to have acceptable transient performance for a variety of load conditions and interconnection topologies.

SONAR-BASED LOCALIZATION OF MOBILE ROBOTS USING THE HOUGH TRANSFORM
Khine Latt-Civilian
B.S.Ch.E., Pennsylvania State University, 1983
Master of Science in Engineering Science-March 1997
Advisor: Xiaoping Yun, Department of Electrical and Computer Engineering
Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

For an autonomous mobile robot to navigate in an unknown environment, it is essential to know the location of the robot on a real-time basis. Finding position and orientation of a mobile robot in a world coordinate system is a problem in localization. Dead-reckoning is commonly used for localization, but position and orientation errors from dead-reckoning tend to accumulate over time. The objective of this thesis is to develop a feature-based localization method that allows a mobile robot to re-calibrate its position and orientation by automatically selecting wall-like features in the environment.

In this thesis, the selection of features is accomplished by applying the Hough transform to sonar data. The Hough transform makes it possible to select the optimal feature (the longest wall, in this case) without finding all possible line segments from the sonar data. A least-square line fitting method is then employed to construct a model of the line segment that represents the feature selected by the Hough transform. The algorithm developed was tested using synthetic and real sonar data. Experimental results demonstrated the effectiveness of the proposed localization methods.

FIELD-SENSITIVE PHOTOCONDUCTIVE SAMPLING PROBE MEASUREMENTS OF A SINGLE EVENT UPSET
Ezra J. Ledbetter, Jr.-Lieutenant, United States Navy
B.A., Hampton University, 1991
Master of Science in Electrical Engineering-June 1997
Advisors: Todd Weatherford, Department of Electrical and Computer Engineering
John F. Whitaker, Department of Electrical Engineering and Computer Science, University of Michigan

This thesis describes the use of a field-sensitive photoconductive sampling probe to measure a Single Event Upset (SEU) induced by an ultra-short optical pulse. The main thrust of the study is to show that a photocurrent can be measured inside of an IC and time resolve the transient of an SEU. The results will be compared to simulation predictions, and new applications for use of the probe will be explored.

This experiment is the first time that an SEU pulse has been measured inside of an IC. The Field-Sensitive photoconductive sampling probe was developed at the Center for Ultrafast Optical Science at the University of Michigan. It is the only one of its kind. This setup is unique, in that it has the capability of making microvolt-sensitivity measurements inside of an IC without conductive contact, therefore, making it noninvasive. The probe is capable of measuring picosecond voltage waveforms through passivation layers without charge drainage.

ELECTROMAGNETIC RESONANCES OF METALLIC BODIES
William Anthony Lintz-Lieutenant, United States Navy
B.E.E., Villanova University, 1992
Master of Science in Electrical Engineering-June 1997
Advisors: Richard W. Adler, Department of Electrical and Computer Engineering
Jovan E. Lebaric, Department of Electrical and Computer Engineering

Every object has the ability to radiate and scatter electromagnetic waves. The ability to predict frequencies of maximum radiation or scattering has been limited to simple objects, such as dipoles, or objects with high degrees of symmetry. This thesis describes modifications that can be made to a computational electromagnetic technique, the Method of Moments, to allow for such predictions to be made for complex metallic objects. This new technique has been implemented as a MATLAB computer program and tested on objects with known resonance frequencies. Finally, the code's ability to handle large complex objects is demonstrated by investigating the resonance frequencies for a Cessna aircraft.

SHEPHERD ROTARY VEHICLE: MULTIVARIATE MOTION CONTROL AND PLANNING
Edward J. Mays-Major, United States Marine Corps
B.S., University of Florida, 1984
M.S., University of Southern California, 1994
Master of Science in Computer Science-September 1997
and
Ferdinand A. Reid-Lieutenant, United States Navy
B.B.A., Georgia State University, 1990
Master of Science in Computer Science-September 1997
Advisor: Yutaka Kanayama, Department of Computer Science
Second Reader: Xiaoping Yun, Department of Electrical and Computer Engineering

Millions of acres of the U.S. formerly used defense sites (FUDS) are contaminated with unexploded ordnance (UXO) as a result of past military use. The process of returning the land to the civilian sector is sensitive, intensive, and costly (e.g., millions of dollars, and the loss of human life). Hence "clearing" (i.e., site remediation, range clearance, and explosive ordnance disposal) UXO's from FUDS is a complex problem. Existing clearing methods are inaccurate, dangerous, and labor intensive. This thesis shows that through robotics technology (e.g., "Shepherd" rotary vehicle with three degrees of freedom) and the use of advanced computer technology it is possible to make clearing tasks safer, more cost-effective, and more efficient. An over arching hardware and software architecture was developed for Shepherd (including a self-contained on-board computer system). The software system was developed for timer control, motion control, user interface, and an operating kernel. The hardware and software organization, structure, and interaction provide the framework for real-time control. This research included the use of encoders, digital boards, and a counter board and required the handling of interrupts, electric motor manipulation by servomotor controllers, and communication using RS232 and VMEbus technology. The kinematics algorithms and a real-time operating kernel were implemented using the C language. "Shepherd" research has laid the foundation for the flexible, robust, and precise motion needed for UXO clearing.

MARTES, A SIGNAL ANALYSIS TOOLKIT FOR THE FUTURE (U)
Edward C. McCarthy-Major, United States Marine Corps
B.S. Mathematics, United States Naval Academy, 1984
Master of Science in Electrical Engineering-December 1996
Advisors: Vicente C. Garcia Jr., National Security Agency Cryptologic Chair
Herschel H. Loomis, Jr., Department of Electrical and Computer Engineering

The ability of the United States to analyze electronic emissions and exploit them effectively is essential to our national defense. In the past two decades numerous digital signal process software programs have been developed by many agencies that attempt to process and exploit the vast number of available signals. This haphazard approach has led to a number of

different agencies using a plethora of software programs to attack signals that are specific to their particular mission. This lack of standardization has led to many problems including information incompatibility, the need for file conversion, and constant need for operators to train on new tools. This thesis will examine the effectiveness of a government software package that attempts to provide a standardized all-purpose digital tool kit which can be added to and used by all government agencies. The thesis will begin by introducing the major features of the software and some of the signal analysis requirements of various agencies. It will then demonstrate the potency of the software by presenting a step-by-step analysis of numerous signals from various arenas. The thesis will then compare the results to some other currently used tools.

THE ANALYSIS, SIMULATION, AND CONTROL OF CYCLOCONVERTER DRIVES FOR SHIP PROPULSION

Christopher Paul Mercer-Lieutenant, United States Navy
B. S., Maine Maritime Academy, 1988
Master of Science in Electrical Engineering-December 1996
Advisor: John G. Ciezki, Department of Electrical and Computer Engineering
Second Reader: Robert W. Ashton, Department of Electrical and Computer Engineering

Naval expeditionary forces of the future will require new, technologically advanced, multi-mission surface combatants. The design philosophy for future surface combatants stresses survivability, efficiency, and modularity through the use of a modern open-architecture consisting of commercial-off-the-shelf and dual-use systems. An integrated propulsion and electrical power generation system which utilizes advanced, commercially viable power electronics and state-of-the-art control and monitoring systems is viewed as the appropriate system for the future surface combatant.

This study provides the designing naval engineer with technical background information and design considerations for the application of a cycloconverter drive for ship propulsion in an integrated power system. The cycloconverter is a power electronic circuit which performs a single-stage conversion of an AC input voltage at one frequency to an ac output voltage of variable frequency and amplitude. Cycloconverters are generally used for low-speed, very large horsepower applications and with suitable closed-loop control can develop torque and speed responses suitable for ship propulsion. External performance characteristics and control issues for the cycloconverter are discussed, followed by a time-domain computer simulation of an integrated ship propulsion drive utilizing a cycloconverter. From the technical background information, external performance characteristics and computer simulation analysis, the designing naval engineer can make educated decisions on the application of a cycloconverter drive for ship propulsion.

A COMPUTATIONALLY EFFICIENT AND COST EFFECTIVE MULTISENSOR DATA FUSION ALGORITHM FOR THE UNITED STATES COAST GUARD VESSEL TRAFFIC SERVICES SYSTEM

Sean A. Midwood-Lieutenant Commander, Canadian Armed Forces
B. Eng., Lakehead University, 1989
Master of Science in Electrical Engineering-September 1997
Advisor: Murali Tummala, Department of Electrical and Computer Engineering
Second Reader: Roberto Cristi, Department of Electrical and Computer Engineering

This thesis develops an algorithm to fuse redundant observations due to multiple sensor (type and location) coverage in order to provide a significant reduction in duplicate track information provided to Vessel Traffic Services (VTS) operator displays. The design of the algorithm allows acceptance of inputs from any type of sensor (radar, acoustic, GPS, system generated, and manual tracks) as long as the basic decision criteria elements are provided. The result of this effort is a computationally efficient and cost effective software solution to a significant system deficiency that impacts greatly on overall waterway safety. The algorithm is tested with real data collected from the VTS system at Puget Sound in September 1996. The results indicate that the algorithm correctly fuses redundant sensor observations on the same vessel resulting in a significant reduction in the amount of unnecessary information presented to the VTS operator.

A MULTI-CHANNEL HIGH-SPEED FIBER-OPTIC DIGITAL DATA LINK

James Howard Mills-Lieutenant, United States Navy
B.A., University of Arizona, 1990
Master of Science in Electrical Engineering-December 1996
Advisor: John P. Powers, Department of Electrical and Computer Engineering
Second Reader: Ron J. Pieper, Department of Electrical and Computer Engineering

This research presents the design, implementation, and testing of a multi-channel, high-speed fiber-optic data link. The aim of this study is to evaluate this data link for use as a viable and economical shipboard communication system. Incorporated in the design are commercial-off-the-shelf technology system (COTS) high-speed fiber-optic modules, standard single-mode optical fiber, and integrated circuits from two digital logic families-Emitter Coupled Logic (ECL) and Transistor-Transistor Logic (TTL). Time division multiplexing (TDM) techniques are used for transmission and reception of the 14-channel data link. The data link is a subsystem of the high-resolution digital antenna system.

OCEAN WAVE DATA ANALYSIS USING HILBERT TRANSFORM TECHNIQUES

Moisés M. Navarro-Lieutenant Commander, Venezuelan Navy
B.S., Venezuelan Naval School, 1982
Master of Science in Applied Physics-December 1996
Advisors: Andrés Larraza, Department of Physics
Roberto Cristi, Department of Electrical and Computer Engineering

A novel technique to determine the phase velocity of long-wavelength shoaling waves is investigated. Operationally, the technique consists of three steps. First, using the Hilbert transform of a time series, the phase of the analytic signal is determined. Second, the correlations of the phases of analytic signals between two points in space are calculated and an average time of travel of the wave fronts is obtained. Third, if directional spectra are available or can be determined from time series of large array of buoys, the angular information can be used to determine the true time of travel. The phase velocity is obtained by dividing the distance between buoys by the correlation time. Using the Hilbert transform approach, there is no explicit assumption of the relation between frequency and wavenumber of waves in the wave field, indicating that it may be applicable to arbitrary wave fields, both linear and nonlinear. Limitations of the approach are discussed.

DESIGN, ANALYSIS, AND PROTOTYPE FOR ONE-CYCLE CONTROLLER

James R. Nelson-Lieutenant, United States Navy
B.S., Auburn University, 1989
Master of Science in Electrical Engineering-December 1996
Advisor: Robert W. Ashton, Department of Electrical and Computer Engineering
Second Reader: John G. Ciezki, Department of Electrical and Computer Engineering

As the Navy progresses into the twenty-first century, new concepts in shipboard electrical power management are being explored. One area of significant interest to the Navy is utilization of DC electrical distribution systems rather than traditional AC distribution systems. The DC Zonal Electrical Distribution System is a prime candidate for direct application to modem power distribution. This system employs solid-state conversion devices to supply ships loads from one of two high-voltage DC busses. A new type of control technique known as One-Cycle Control has recently been proposed which may be of use in the control of these power converters. Specific advantages of this technique include no steady-state or dynamic error between the control signal and the controlled variable, robust performance, power source perturbation rejection, fast dynamic response to changes in the control signal, general switching applications, and automatic switching error correction. The focus of this thesis is to validate the One-Cycle Control theory through simulation and testing of a prototype controller.

SUPPLEMENTING NATIONAL SYSTEM SUPPORT TO THE WARFIGHTER: SIGINT CAPABLE UNMANNED AERIAL VEHICLES (UAVS) (U)

Karla J. Nemec-Lieutenant, United States Navy
B.A., University of Missouri, Columbia, 1990
Master of Science in Space Systems Operations-September 1997
Advisors: Vicente Garcia, National Security Agency Cryptologic Chair
Professor Herschel Loomis, Department of Electrical and Computer Engineering

Unmanned Aerial Vehicles (UAVs) represent a platform that could supplement future national system Signals Intelligence (SIGINT) support to the warfighter with the development of proper payloads and procedures, as explored in this thesis. Payload designs must ensure collection capability against the complex, dynamic communications and non-communications threats emerging worldwide. Multi-platform Time and Frequency Difference of Arrival (TDOA/FDOA) geolocation methodologies must complement payload single-platform direction finding capabilities to allow cooperative, precision target geolocation while maintaining independent platform operations capability. Standardized, all-source, automated processing tool kits must allow interoperability between collection platform processing facilities and automated processing whenever possible. To effect the interoperable collection, geolocation and processing capabilities and ensure rapid dissemination of valuable SIGINT information, a robust network of high data rate links must be established. The data links provide the connectivity necessary to accommodate specific cooperative UAV/national system activities envisioned by the author. These key activities include cooperative geolocation, cross-cueing, and data relay operations. In developing the UAV and cooperative UAV/national system SIGINT concepts discussed in this thesis, SIGINT planners provide the warfighter with sustained, improved SIGINT collection in areas and situations too dangerous for collection via other means.

OPTIMUM CODES FOR FAST FREQUENCY-HOPPED BINARY FREQUENCY-SHIFT KEYING RECEIVERS WITH SELF-NORMALIZATION COMBINING AND HARD DECISION DECODING IN FADING CHANNELS

Xenofon Nikolakopoulos-Lieutenant, Hellenic Navy
B.S.E.E, Hellenic Naval Academy, 1988
Master of Science in Electrical Engineering-March 1997
Advisors: Tri T. Ha, Department of Electrical and Computer Engineering
R. Clark Robertson, Department of Electrical and Computer Engineering

The application of forward error correction coding to a fast frequency-hopped binary frequency-shift keying (FFH/BFSK) noncoherent receiver with self-normalization combining under broadband and partial-band jamming is discussed in this thesis.

The performance of the receiver is examined when data are encoded using Reed-Solomon codes, convolutional codes, and concatenated Reed-Solomon and convolutional codes, all with hard decision decoding. The effects of the transmission channel is considered and results are derived for a Rayleigh fading channel and Ricean fading channels with several different ratios of direct-to-diffuse signal power. Only frequency nonselective, slowly fading channels are considered.

The combination of diversity and forward error correction coding is found to improve the performance of the receiver in the presence of both broadband and partial-band jamming and optimum codes for each coding scheme are also discussed.

VIDEO CONFERENCING USING PACKET RADIO TECHNOLOGY

Narongchai Nimitbunanan-Second Lieutenant, Royal Thai Air Force
B.S., U.S. Air Force Academy, 1995
Master of Science in Systems Engineering-June 1997
Advisor: Chin-Hwa Lee, Department of Electrical and Computer Engineering
Second Reader: Supachai Sirayanone, Department of Meteorology

Information and its effective delivering means are becoming more and more important in today's world. Video-conferencing is a highly effective means to deliver information since it is interactive. This thesis studies the packet-radio-networking technology that can be used to support video-conferencing applications. The popular networking protocols, i.e., the Amateur X.25 (AX.25), the Transport Control Protocol/Internet Protocol (TCP/IP), and other protocols, widely used in packet radio technology are described. By using the File Transfer Protocol (FTP) of the TCP/IP standard, the average speed and time of various file sizes across a half-duplex radio channel, a full-duplex emulated-radio channel, and a RS-232 link were collected and analyzed. Finally, comparisons were made among channels, including the effects of an additional routing node.

ALTERNATIVE GATE DESIGNS FOR IMPROVED RADIATION HARDNESS IN BULK CMOS INTEGRATED CIRCUITS

Sidney Scott Noe-Lieutenant, United States Navy
B.S., Rochester Institute of Technology, 1989
Master of Science in Electrical Engineering-March 1997
Advisor: Douglas J. Fouts, Department of Electrical and Computer Engineering
Second Reader: Todd R. Weatherford, Department of Electrical and Computer Engineering

In the last 30 years, the world has become increasingly dependent on space-based systems. These systems require varying degrees of radiation tolerance to perform their missions. Current radiation hardening processes for integrated circuits are expensive and consume significant layout area, increase power consumption, and decrease the frequency of operation. Furthermore, it is becoming more difficult to find fabricators for radiation-hardened electronic devices. In this thesis, two new transistor designs using a bulk CMOS process are tested for radiation hardness and are compared to a standard design. Both show a degree of improvement in subthreshold leakage current and threshold voltage shift over the control transistors. The new designs demonstrate an ability to reduce the effects of radiation on transistor parameters by means of an applied voltage to a second layer of polysilicon material above the control gate material.

THE OPERATION AND INTERACTION OF THE AUXILIARY RESONANT COMMUTATED POLE CONVERTER IN A SHIPBOARD DC POWER DISTRIBUTION NETWORK

Mark J. Oberley-Lieutenant, United States Navy
B.S., Colorado School of Mines, 1989
Master of Science in Electrical Engineering-December 1996
Advisor: John G. Ciezki, Department of Electrical and Computer Engineering
Second Reader: Robert W. Ashton, Department of Electrical and Computer Engineering

The objective of this thesis is to investigate the use of the Auxiliary Resonant Commutated Pole Converter (ARCP) as a DC-to-AC power converter. The advantages and disadvantages of resonant converters over non-resonant, or hard-switched converters, are investigated. Basic ARCP circuit operation is modeled, with emphasis placed on examining the commutation between high and low voltage states. Detailed ARCP converter operation is modeled in software and compared to a software model of a hard-switched converter. Comparisons are made using total harmonic distortion calculations, to establish the reliability of using the hard-switched model to perform control synthesis for the ARCP.

Several control algorithms are tested through simulation and the results analyzed. The advantages of performing control in the synchronous vice stationary reference frame are shown. Testing on a reduced-scale circuit model using a digital signal processing system (dSPACE) to implement control algorithms is used to validate the control algorithm simulations.

A new method of waveform modulation, Space Vector Control, is introduced and compared with conventional methods. Finally the operation of a prototype ARCP unit is discussed, and recommendations for improvements in future designs are presented.

THE VLSI IMPLEMENTATION OF A GaAs GIC SWITCHED CAPACITOR FILTER
Harry Garrett Oldland, III-United States Marine Corps
B.A., Pennsylvania State University, 1982
Master of Science in Electrical Engineering-June 1997
Advisor: Sherif N. Michael, Department of Electrical and Computing Engineering
Second Reader: Raymond F. Bernstein Jr., Department of Electrical and Computing Engineering

Presented is the initial step for the eventual implementation of a programmable Generalized Immitance Converter (GIC) switched capacitor filter in a GaAs process. This thesis is the initial engineering effort in the accomplishment of this goal. The focus of this thesis is to design, fabricate, and test of all necessary components for the construction of a GIC switched capacitor filter. All components will be stand alone so that future testing of each component may be accomplished. VLSI implementation will be accomplished using the Magic Cad package and the Vitesse HGaAs3 fabrication process. The simulation of the components will be accomplished using HSpice.

DETECTION AND ESTIMATION OF FREQUENCY HOPPING SIGNALS USING WAVELET TRANSFORMS
Howard F. Overdyk-Captain, United States Marine Corps
B.S., Iowa State University, 1991
Master of Science in Electrical Engineering-September1997
Advisors: Monique P. Fargues Department of Electrical and Computer Engineering
Ralph Hippenstiel, Department of Electrical and Computer Engineering

This thesis investigates the use of wavelet transforms in the detection and estimation of spread spectrum frequency hopping signals. The technique developed in this work makes only two basic assumptions of a minimum hopping time and a minimum frequency hopping differential. The approach is based on the phase information of the temporal correlation function and the resulting discrete wavelet transform is used to estimate the hopping time of frequency hopping signals. Results show the proposed scheme is robust to additive white noise for SNR levels of 3 dB and above.

DESIGN AND PROTOTYPE DEVELOPMENT OF AN OPTIMUM SYMMETRICAL NUMBER SYSTEM DIRECTION FINDING ARRAY
Panayiotls Papandreou-Lieutenant Junior Grade, Hellenic Navy
B.S., Hellenic Naval Academy, 1989
Master of Science in Electrical Engineering-March 1997
Advisors: Phillip E. Pace, Department of Electrical and Computer Engineering
David C. Jenn, Department of Electrical and Computer Engineering

One method of estimating the direction of an electromagnetic source is based on phase comparison. In this thesis the design and fabrication of a prototype antenna to demonstrate a new DF antenna architecture is described. Four antenna elements are grouped into three pairs with element spacing according to a set of symmetrical number system pairwise relatively prime moduli (m_1=3, m_2= 4, m_3=5). The phase difference between each pair of elements is a symmetrical folding waveform that is determined using a mixer. The output voltage from each pair is amplitude analyzed using a small comparator ladder. In each channel, the symmetrically folding waveform, folds in accordance with the channel modulus and thus, only requires a precision according to that modulus. A high resolution DF is achieved after the N different SNS moduli are used and the results of these low-precision channels are recombined to yield the direction of arrival. The frequency of operation of the prototype is 8.5 GHz. Results based on measured and simulated data are presented.

SINGLE-EVENT ANALYSIS OF LT GaAs MESFET INTEGRATED CIRCUITS
Richard Anthony Radice-Lieutenant, United States Navy
B.S., United States Naval Academy, 1990
Master of Science in Electrical Engineering-September 1997
Advisor: Todd Weatherford, Department of Electrical and Computer Engineering
Second Reader: Douglas J. Fouts, Department of Electrical and Computer Engineering

There is a growing need for the use of electronics in radiation environments such as space. Gallium arsenide (GaAs) semiconductor technology is highly desirable for these applications because it consumes less power at higher speeds than silicon (Si) and shows superior radiation hardness over silicon technologies except for Single-Event-Upset (SEU). This thesis examines GaAs MESFETs fabricated in the Vitesse H-GaAsIII® process utilized in Direct Coupled FET Logic (DCFL) inverters. These simulations are targeted at determining the vulnerability of these devices to SEU. MESFETs fabricated on low-temperature grown GaAs (LT GaAs) epitaxial layers are investigated in addition to the conventional MESFET process using only bulk GaAs. Two-dimensional computer simulations are performed to determine the most effective method to simulate SEU charge collection mechanisms and how effective the LT GaAs buffer layer is at reducing SEU vulnerability. This thesis is part of a larger project that is attempting to develop a new wafer design that can be inserted into the current Vitesse fabrication process to produce radiation-hardened circuits. Computer simulations are performed using MIXEDMODE®, which is a SPICE simulator for the ATLAS® device simulation software created by SILVACO International Inc.®

PCM INFRASTRUCTURE TECHNOLOGIES
Mark D. Randolph-Lieutenant, United States Navy
B.S., Rensselear Polytechnic Institute, 1990
Master of Science in Electrical Engineering-December 1996
Advisors: Herschel H. Loomis, Jr., Department of Electrical and Computer Engineering
Vicente C. Garcia, Jr., National Security Agency Cryptologic Chair

In today's modern communication environment high data rate synchronous and plesiochronous pulse coded modulations signals fill the air around us. This thesis looks at the formation of these modern communication "shell structures" and explores possible techniques for identifying underlying data structure signatures within the overall shell without decomposition of the outer structure. Simple Fourier Transform techniques are examined along with Cyclostationary processing techniques. This thesis accomplishes three tasks. First it forms an accurate and concise manual for understanding modern digital communications. Next this work provides a groundwork of traditional as well as contemporary techniques (such as cyclostationarity) for study of these signals. Finally, this thesis studies the effects on underlying periodicity and statistical periodicity as the signal shell is developed.

DESIGN, CONSTRUCTION, AND ANALYSIS OF A 14-BIT DIRECT DIGITAL ANTENNA UTILIZING OPTICAL SAMPLING AND OPTIMUM SNS ENCODING
William P. Ringer-Lieutenant, United States Navy
B.S.E.E., University of Washington, 1990
Master of Science in Electrical Engineering-September 1997
Advisor: Phillip E. Pace, Department of Electrical and Computer Engineering
Second Reader: John P. Powers, Department of Electrical and Computer Engineering

Direct digital direction finding (DF) antennas will allow an incoming signal to be digitally encoded at the antenna with high dynamic range (14 bits 86 dB) without the use of down conversion that is typically necessary. As a shipboard DF device, it also allows for the encoding of wide-band, high-power signals (e.g., ± 43 volts) that can often appear on shipboard antennas due to the presence of in-band transmitters that are located close by. This design utilizes three pulsed-laser driven Mach-Zehnder optical interferometers to sample the RF signal. Each channel requires only 6-bit accuracy (64 comparators) to produce an Optimum Symmetrical Number System (OSNS) residue representation of the input signal. These residues are

then sent to a locally programmed Field Programmable Gate Array (FPGA) for decoding into a 14-bit digital representation of the input RE voltage. Modern day FPGA devices are rapidly becoming the state-of-the art in programmable logic. The inclusion of on-chip flip-flops allows for a fast and efficient pipelined approach to OSNS decoding. This thesis documents the first 14-bit digital antenna which utilizes an FPGA algorithm as a method of OSNS decoding. This design uses FPGA processors for both OSNS decoding and Parity processing.

A CODED ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING SIMULATION OF A HIGH DATA RATE, LINE-OF-SIGHT, DIGITAL RADIO FOR MOBILE MARITIME COMMUNICATIONS

David V. Roderick-Civilian
B.S.E.E., University of New Haven, 1987
M.S.E.E., University of Maryland, 1982
Electrical Engineer-June 1997
Advisor: Paul H. Moose, Department of Electrical and Computer Engineering
Second Reader: R. Clark Robertson, Department of Electrical and Computer Engineering

The Naval Command, Control and Ocean Surveillance Center (NCCOSC), Research Development Evaluation (RDT&E) Division's (NRaD) Communications Department is conducting applied research toward the development of a high-data-rate (HDR), line-of sight (LOS), digital modem for ship-to-ship, ship-to-shore, and ship-to-relay communications. Development of bandwidth efficient HDR communications in a maritime radio environment is a challenging research problem due to the time-varying propagation effects within the marine layer. Marine layer propagation typically causes fading of the signal spectrum due to RF interference effects, and intersymbol interference because of multipath induced time spreading. The use of adaptive equalization to overcome distortions is difficult in this environment because of the dynamic nature of the signal propagation caused by transmitter and/or receiver motion and the maritime layer atmospheric effects. An alternative to channel equalization is the application of Coded Orthogonal Frequency Division Multiplexing (COFDM) which overcomes distortion effects without equalization through its orthogonality properties. This thesis explores the application of COFDM toward a HDR LOS maritime communications modem. The modem model is emulated in a high level programming language (MATLAB) and simulations are performed. Analysis of the simulations are conducted and evaluated as to the feasibility of a COFDM implementation in the presence of known noise and signal fading conditions.

HIGH-ACCURACY DISTRIBUTED SENSOR TIME-SPACE-POSITION INFORMATION SYSTEM FOR CAPTIVE-CARRY FIELD EXPERIMENTS

Andrew W. Rowe-Lieutenant, United States Navy
B.S., United States Naval Academy, 1987
Master of Science in Applied Physics-December 1996
Advisor: Phillip E. Pace, Department of Electrical and Computer Engineering
Second Reader: Robert C. Harney, Department of Physics

Operational EW test and evaluation experiments require that the position of the aircraft and other moving objects on the range be known precisely as a function of time. Terminal Time-Space-Position Information (TSPI) Systems involve the range platforms interacting at close distances and therefore require precise trajectory information over a restricted volume of space. Terminal TPSI systems are used for tactics evaluation and the evaluation of simulated weapons firings (e.g., captive-carry hardware-in-the-loop missile simulators). Distributed sensor TSPI systems consist of two or more measurement sensors located some distance from each other. Each sensor makes a measurement of target angle and range. Distributed sensor systems are more complex than single-point systems involving multiple hardware installations, complex mathematical computations to extract coordinate information, synchronization of multiple measurements and calibration of a number of different stations.

This paper presents a novel distributed sensor TSPI architecture that provides precise positioning information of the target relative to a fixed inertial coordinate system. The architecture efficiently integrates the information from an inertial navigation system (INS), a global positioning system (GPS) and any number of distributed RF sensors which may be located onboard a captive-carry aircraft. The significance of this work is that by knowing the target's position in a fixed inertial frame of reference (derived from the integration process) an evaluation can be made as to the effectiveness of any electronic attack or off-board decoys that might have been launched during the field test scenario. The induced INS, GPS and sensor noise and the corresponding errors due to the integration process are evaluated numerically as a function of the weapon system being used. The accuracy in the targeting information is also quantified and compared with the true expected values.

IN-SITU TESTING OF RADIATION EFFECTS ON VLSI CAPACITORS USING THE NPS LINEAR ACCELERATOR

Duane Salsbury-Lieutenant, United States Navy
B.S., University of Washington, 1987
Master of Science in Electrical Engineering-December 1996
Advisor: Sherif Michael, Department of Electrical and Computer Engineering
Second Reader: Todd Weatherford, Department of Electrical and Computer Engineering

The study of radiation effects on VLSI components is a very heavily researched topic. There are several reasons for this research, one of which is the application of VLSI components to space related vehicles. One component essential to Analog VLSI elements is the capacitor. The purpose of this paper is to better define the actual effects of radiation on the MOS VLSI capacitor. The radiation testing is conducted using the NPS electron linear accelerator. The data is taken while the capacitor is being exposed to an accumulating dose of electron radiation. The capacitance values are monitored using the parameter changes of a specially designed low pass filter circuit. The 3 dB breakpoint frequency of this filter is used to calculate the actual capacitance. The capacitance value is then related to the accumulated radiation dose in Rads. The results are very important and needed, especially if off-the-shelf components are to be utilized in the design of spacecraft systems.

DESIGNING FAST GOLAY ENCODER/DECODER IN XILINX XACT WITH MENTOR GRAPHICS CAD INTERFACE

Mehmet Sari-Lieutenant Junior Grade, Turkish Navy
B.S., Turkish Naval Academy, 1991
Master of Science in Electrical Engineering-March 1997
Advisor: Chin Hwa Lee, Department of Electrical and Computer Engineering

The programmable logic array is one of the most fascinating and fast developing areas of technology. Field programmable gate arrays are becoming prevalent in design as the density of the gate arrays goes up. In this study, a fast encoding/decoding algorithm, Extended Golay Coding, is implemented in Xilinx XC4000 family programmable gate array (FPGA) architecture. The encoder/decoder is designed using the Xilinx XACT tool with the Mentor Graphics schematic capture Design Architect (DA) and QuicksimII simulation interfaces. With the static RAM bits onboard the new Xilinx FPGAs, the architecture is more powerful, and it is relatively easy to upgrade the old design based on the needs of the users. In this thesis, fast encoder/decoder is implemented with transmission word redundancy and interleaving. This is based on the data link layer description of the Milstd 181-144A. The FPGA static RAM bits are used for the encode and decode ROM of the algorithm that makes the coder faster. Modular approach and design hierarchy made design tasks easier and upgradable in this study. The timing simulations of some design modules will be presented. Due to the complexity of the circuits, it is found that the design has to be migrated to a higher density chip than XC4003 used in the simulations.

THE DESIGN AND INSTALLATION OF A GLOBAL BROADCAST SERVICE DEMONSTRATION PROJECT AT THE NAVAL POSTGRADUATE SCHOOL

Keith E. Schaffler-Lieutenant, United States Navy
B.S., Clarkson University, 1987
Master of Science in Information Technology Management-March 1997
Advisors: Paul H. Moose, Department of Electrical and Computer Engineering
Rex Buddenberg, Department of Systems Management

The author presents a detailed description of the design and installation of a Global Broadcast Service (GBS) demonstration and evaluation project at the United States Naval Postgraduate School. GBS is a Department of Defense CONUS-based Direct Broadcast Satellite (DBS) evaluation project utilizing commercial, off-the-shelf components for the reception of video, Internet Protocol (IP) and Asynchronous Transfer Mode protocol (ATM) data transmission. Direct Broadcast Satellite technology offers enormous digital relay capability with data transmission speeds on the order of 30 Mbps being available on a single satellite transponder. As modern computer and communications devices now employed by each of the armed services need access to wideband data channels to effect efficient and timely communications, this capacity has generated significant interest within the DoD. The author discusses several key DBS technical areas, including video compression methods, data throughput capacity, polarization, and frequency biasing. Proper installation techniques and suggestions are presented, in addition to other useful DBS-related material. Many significant difficulties experienced during design, installation, and initialization of the NPS testbed are discussed in detail. The author presents this information to help subsequent GBS project participants decrease the time required to design, procure, and install a semi-permanent GBS receive suite.

DESIGN, TESTING, AND EVALUATION OF GaAs PN SEQUENCE GENERATOR CIRCUITS IMPLEMENTED IN DIRECTLY COUPLED FET LOGIC (DCFL) AND TWO PHASE DYNAMIC FET LOGIC (TDFL)

Michael Warren Schimpf-Lieutenant, United States Navy
B.S., Massachusetts Institute of Technology, 1987
Master of Science in Electrical Engineering-September 1997
Advisor: Douglas J. Fouts, Department of Electrical and Computer Engineering
Second Reader: Todd R. Weatherford, Department of Electrical and Computer Engineering

Spaceborne and military communications hardware demands very high-speed circuitry even under high radiation exposure. GaAs field effect transistors have the desirable quality that they possess rapid switching rates and are inherently more resistant to total-dose radiation induced failure than their silicon CMOS counterparts. This thesis project involves the design, simulation, and submission for fabrication, testing, and evaluation of a 1-GHz, 7-bit, pseudo-noise sequence generator (PNSG) which has numerous communications applications, particularly in spread-spectrum communications. The basic design of the PNSG is provided first, then topology-specific design considerations are covered for directly coupled FET logic (DCFL) and two-phase dynamic FET logic (TDFL) implementations. Analysis and comparison of circuit performance characteristics are completed, demonstrating the significant improvements in speed, layout area, and power consumption that dynamic logic offers.

EXPECTED PERFORMANCE OF THE GLOBAL BROADCAST SERVICE, (GBS) PHASE II, WITH EMPHASIS ON ENVIRONMENTAL LIMITATIONS TO SUPPORTABLE DATA RATES

Stephen D. Scotty-Lieutenant, United States Navy
B.A., University of Texas at Austin, 1990
Master of Science in System Technology-June 1997
Advisors: Paul H. Moose, Department of Electrical and Computer Engineering
Tri T. Ha, Department of Electrical and Computer Engineering

The U.S. military requires a high capacity, high availability broadcast capability to provide timely dissemination of standard products to users who cannot rely on terrestrial links. The Global Broadcast Service (GBS) is being developed to meet this requirement. The key limiting factor in GBS availability is environmental losses, specifically atmospheric absorption and rainfall loss. The optimum frequency band for GBS would have been between 1-10 GHz. At this frequency range, environmental losses are negligible. However, congestion in this frequency range has forced DoD to choose a much higher frequency band for GBS, 20/30 GHz (K/Ka band). At this frequency band environmental losses, specifically rain loss, will be a key limiting factor to GBS availability. This thesis analyzes GBS Phase II performance taking into account atmospheric limitations. A key problem in determining the performance of GBS lies in the accuracy of existing rain loss models. Several rain loss prediction models were considered, and based on studies conducted by the ITU-R and Stanford Telecom, the USA rain model was chosen for this analysis. This thesis has shown that, due to environmental losses, high availability can best be achieved if GBS is capable of lowering its data rate during periods of precipitation.

AN ADAPTIVE METHOD FOR THE ENHANCED FUSION OF LOW-LIGHT VISIBLE AND UNCOOLED THERMAL INFRARED IMAGERY

James W. Scrofani-Lieutenant, United States Navy
B.S.Ch.E., University of Florida, 1987
M.B.A., Brenau University, 1994
Master of Science in Electrical Engineering-June 1997
Advisor: Charles W. Therrien, Department of Electrical and Computer Engineering
Second Reader: William K. Krebs, Department of Operations Research

Night vision sensors, such as image-intensifier (II) tubes in night vision goggles and forward looking infrared sensors (FLIR) are routinely used by U.S. naval personnel for night operations. The quality of imagery from these devices however, can be extremely poor. Since these sensors exploit different regions of the electromagnetic spectrum, the information they provide is often complementary, and therefore, improvements are possible with the enhancement and subsequent fusion of this information into a single presentation. Such processing can maximize scene content by incorporating information from both images as well as increase contrast and dynamic range. This thesis introduces a new algorithm, which produces such an enhanced/fused image. It performs adaptive enhancement of both the low-light visible (II) and thermal infrared imagery (IR) inputs, followed by a data fusion for combining the two images into a composite image. The methodology for visual testing of the algorithm for comparison of fused and original II and IR imagery is also presented and a discussion of the results is included. Tests confirmed that the fusion algorithm resulted in significant improvement over either single-band image.

SINGLE EVENT ANALYSIS OF LOW TEMPERATURE GALLIUM ARSENIDE FIELD EFFECT TRANSISTOR TECHNOLOGY

Michael L. Shumberger-Lieutenant, United States Navy
B.S., University of Puget Sound, 1989
Master of Science in Electrical Engineering-March 1997
Advisor: Todd R. Weatherford, Department of Electrical and Computer Engineering
Second Reader: Douglas J. Fouts, Department of Electrical and Computer Engineering

Previous research has indicated that up to an eight order-of-magnitude reduction in the single-event upset (SEU) rate may be possible by using a buried low temperature (LT) grown buffer layer beneath the transistors in GaAs ICs. A two-dimensional model for the complementary GaAs heterostructure riFET of the Motorola CGaAs™ fabrication process is developed and device performance and SEU susceptibility is characterized. The model was investigated to: 1) compare conventional GaAs FET technology to GaAs FETs fabricated on LT GaAs buffers and 2) perform SEU simulations in a CGaAs™ Inverter to characterize SEU susceptibility of the LT GaAs FET.

INTERACTION OF LASER BEAMS WITH RELATIVISTIC ELECTRONS

Douglas W. Small-Lieutenant-United States Navy
B.S., Marquette University, 1988
Doctor of Philosophy in Physics-March 1997
Advisors: William B. Colson, Department of Physics
Robert L. Armstead, Department of Physics
Karlheinz E. Woehler, Department of Physics
James H. Luscombe, Department of Physics
Ron J. Pieper, Department of Electrical and Computer Engineering

Motivated by the desire to put a free electron laser (FEL) weapon on a ship, the FEL and the related process of Compton backscattering are studied. The theme of the majority of this work is the interaction of the Gaussian optical mode with a beam of relativistic electrons.

Classical FEL theory is reviewed in Chapter II. Simulations based on the classical theory are used in Chapter III to study a proposed 1 kW (kilowatt) infrared FEL. In Chapter IV, simulation is used to study the problem of electron beam/optical mode overlap in an ultraviolet (UV) FEL. A new concept, the FEL with a short Rayleigh length, is studied in Chapter V. The idea is tested on the UV FEL, then used to design and simulate a megawatt-class FEL for ship self-defense.

An analytical calculation of the Compton backscattering of laser light is performed in Chapter VI. A quantum electrodynamics (QED) formalism is used to find the spectrum and angular distribution of photons scattered out of a Gaussian optical mode by relativistic electrons.

FINAL DESIGN, INTEGRATION, AND VALIDATION OF THE PANSAT ANTENNA SYSTEM

Gary J. Smilowitz-Lieutenant Commander, United States Navy
B.E.E.E., Vanderbilt University, 1985
Master of Science in Electrical Engineering-March 1997
Advisor: Richard W. Adler, Department of Electrical and Computer Engineering
Second Reader: Rudolf Panholzer, Space Systems Academic Group

In this thesis, the final design for the Petite Amateur Navy Satellite (PANSAT) antenna system is constructed, integrated, and validated. The antenna elements and matching network are field tested and compared to the Numerical Electromagnetics Code (NEC) model. The final free-space radiation pattern and its power gain distribution will be used to help track PANSAT's rotation during its orbit.

A SIGNAL PROCESSING PERSPECTIVE OF HYPERSPECTRAL IMAGERY ANALYSIS TECHNIQUES

Marcus Stavros Stefanou-Captain, United States Marine Corps
B.S., United States Naval Academy, 1990
Master of Science in Electrical Engineering-June 1997
Advisors: Richard C. Olsen, Department of Physics
Roberto Cristi, Department of Electrical and Computer Engineering

A new class of remote sensing data with great potential for the accurate identification of surface materials is termed hyperspectral imagery. Airborne or satellite imaging spectrometers record reflected solar or emissive thermal electromagnetic energy in hundreds of contiguous narrow spectral bands. The substantial dimensionality and unique character of hyperspectral imagery require techniques which differ substantially from traditional imagery analysis. One such approach is offered by a signal processing paradigm, which seeks to detect signals in the presence of noise and multiple interfering signals.

This study reviews existing hyperspectral imagery analysis techniques from a signal processing perspective and arranges them in a contextual hierarchy. It focuses on a large subset of analysis techniques based on linear transform and subspace projection theory, a well established part of signal processing. Four broad families of linear transformation-based analysis techniques are specified by the amounts of available a priori scene information. Strengths and weaknesses of each technique are developed. In general, the spectral angle mapper (SAM) and the orthogonal subspace projection (OSP) techniques gave the best results and highest signal-to-clutter ratios (SCRs). In the case of minority targets, where a small number of target pixels occurred over the entire scene, the low probability of detection (LPD) technique performed well.

THE USE OF COMMERCIAL LOW EARTH ORBIT SATELLITE SYSTEMS TO SUPPORT DOD COMMUNICATIONS

Haralambos Stelianos-Captain, Hellenic Army
B.S.E.E., National Technical University of Athens, 1993
Master of Science in Electrical Engineering-December 1996
Advisors: Tri T. Ha, Department of Electrical and Computer Engineering
Vicente Garcia, National Security Affairs Cryptologic Chair

Within the next five years there will be a proliferation of commercial Low Earth Orbit (LEO) satellite systems providing voice/data services to anywhere in the world. Instead of investing heavily in new satellite systems, the military services can use these forthcoming commercial satellite systems to enhance their existing satellite-based systems. An in-depth study and detailed summary is provided in this thesis for each of the following four commercial LEO satellite systems: Iridium, Teledesic, Odyssey, and Globalstar. Then, a comparison of these systems is performed from the military point of view by using criteria such as antijam protection, security, mobility, flexibility, interoperability, coverage, and capacity. It is shown that an architecture consisting of Globalstar and Odyssey has the potential to provide communications support for DoD's less critical needs which include administration, logistics, and other support functions. Finally, other military applications of these systems are given.

APPLICATION OF CYCLOSTATIONARY SIGNAL SELECTIVITY TO THE CARRY-ON MULTI-PLATFORM GPS ASSISTED TIME DIFFERENCE OF ARRIVAL SYSTEM

David A. Streight-Lieutenant, United States Navy
B.S., United States Naval Academy, 1990
M.B.A., National University, 1994
Master of Science in Electrical Engineering-March 1997
Electrical Engineer-March 1997
Advisors: Herschel H. Loomis, Jr., Department of Electrical and Computer Engineering
Gus K. Lott, Department of Electrical and Computer Engineering

Traditional methods of time difference of arrival (TDOA) determination suffer significantly in environments fraught with co-channel interference and low signal to noise ratios. Cyclostationary signal processing techniques offer solutions to the shortcomings of the traditional TDOA methods. Specifically, the Spectral Coherence Alignment (SPECCOA) method of TDOA determination, developed by the Mission Research Corp. and Statistical Signal Processing Inc., performs exceptionally in very poor signal to noise ratio environments. The Applied Research Lab at the University of Texas at Austin (ARL:UT) has developed a prototype TDOA system, the Carry-on Multi-platform GPS Assisted Time Difference of Arrival System for the Naval Information Warfare Activity. It currently utilizes a traditional complex ambiguity function (CAF) to determine the TDOA(s) between multiple observers and an ARL:UT developed closed form solution for the geolocation of the emitter. The work presented here takes the first step in applying SPECCOA to the ARL:UT system. Coding both SPECCOA and the ARL:UT closed form solution in MATLAB® makes possible a quantitative comparison between the CAF and SPECCOA using ARL:UT real world test signals.

DESIGN, CONSTRUCTION, AND PROGRAMMING OF A MICROCONTROLLER-BASED TESTBENCH SUITABLE FOR RADIATION TESTING OF MICROELECTRONIC CIRCUITS

John A. Thompson-Lieutenant, United States Coast Guard
B.S. Old Dominion University, May 1992
Master of Science in Electrical Engineering-March 1997
Advisor: Douglas Fouts, Department of Electrical and Computer Engineering
Second Reader: Todd Weatherford, Department of Electrical and Computer Engineering

This thesis describes the design, construction, and programming of a microcontroller-based testbench suitable for radiation testing microelectronic integrated circuits. It will be used to test circuits fabricated using the Low Temperature Gallium Arsenide (LT GaAs) fabrication process developed by the Naval Postgraduate School and the Naval Research Laboratory. The testbench will be used to test for sensitivity to Single Event Upsets (changes in logic level due to impact by high-energy ions). Due to the spurious radiation around the particle accelerator, it will be remotely operated via a serial communication port. Radiation hardened components will eventually be used throughout, although for cost-savings, non-radiation hardened components are used in the initial design described here. The test bench is built around the Intel 87C51 four-port microcontroller. As part of this research, it will be programmed to test two memory chips, one manufactured by Motorola Inc. and one by Vitesse Semiconductor Corporation. The Motorola chip requires that a special chip carrier with logic translation and output drivers be designed prior to testing.

ECONOMIC EVALUATION OF VOICE RECOGNITION (VR) FOR THE CLINICIANS' DESKTOP AT THE NAVAL HOSPITAL ROOSEVELT ROADS (NHRR)

Erik Threet-Lieutenant, United States Navy
B.S., University of Central Arkansas, 1987
M.B.A., City University, 1991
Master of Science in Information Technology Management-September 1997
Advisors: Monique P. Fargues, Department of Electrical and Computer Engineering
William R. Gates, Department of System Management

Beyond keyboards, mice, trackballs, and other means to communicate with computers, the spoken word remains the ultimate, if not elusive, user interface. Recent developments in hardware and software have brought the ability to control a computer with the spoken word closer to reality. This thesis investigates the current status of VR technology, its use in support of Joint Vision 2010, its use in the Healthcare environment and provides an analysis of the VR Pilot Project at NHRRs. The objective of the analysis is to determine the viability and economical benefits of using a commercial-off-the-shelf (COTS) VR application as a clinicians input device for transcribing clinical encounter (SOAP) notes. The VR application used in this study was the DragonDictate Classic Edition with the DragonMed add on module for healthcare professionals.

The results show that VR technology is a viable tool that can add numerous economical benefits, such as, a decrease in the time clinicians spend transcribing SOAP notes, eliminates the need to hire medical transcriptionists and reduces Graphical User Interface (GUI) overload for Window's based Navy Medical Standard systems. In addition, findings indicate that the use of computer technology, during clinical encounters, has no significant effect on patient/clinician relationships.

THE ASTRODYNAMIC PROBLEMS OF DIGITAL TDMA SIGNAL DETECTION

Nicholas E. Triska-Lieutenant, United States Navy
B.S., Oregon Institute of Technology, 1986
Master of Science in Electrical Engineering-December 1996
Advisors: Herschel H. Loomis, Jr., Department of Electrical and Computer Engineering
Vicente C. Garcia, National Security Affairs Cryptologic Chair

Worldwide consumer demand for personal digital communications products and services has been explosive. Many U.S. and foreign corporations have plunged into the market with high quality electronic components and communications services far in advance of those currently used by today's operating forces. Several satellite systems are being readied for launch that will enable private citizens, commercial enterprises and other entities to communicate from anywhere to anywhere in the world. Cellular communications networks offer developing countries that have little or no communications infrastructure significant cost savings when compared to traditional wireline setups; it satisfies the most basic communications requirements without a hefty investment m copper cable. Modern systems allow this communication to occur in secure voice or data, operating in the networked, broadcast, or point to point modes. For military applications, the detection of advanced digital TDMA signals from space in a hostile environment involves a number of problems. Several of these are addressed.

ESTABLISHING A SIGNALS ANALYSIS WORKSTATION (U)

Thomas G. Trotter-Lieutenant, United States Navy
B.S.E.E., United States Naval Academy, 1988
Master of Science in Electrical Engineering-December 1996
Advisors: Vicente C. Garcia, National Security Affairs Cryptologic Chair
Herschel H. Loomis, Jr., Department of Electrical and Computer Engineering

In an era of the information age, the advent of digital hardware technology has enabled digital signal processing techniques to flourish and transform communications from analog to digital formats. Unlike analog communication systems, digital communication systems interface inherently easily with computer hardware and software processes. Such a relationship

has propelled the users forward with endless transmission possibilities. Former methods dedicated to the venerable analog systems are antiquated and utterly useless against this new class of digital transmissions. This same new technological power available to the intended communication system users is also available to third parties engaged in exploiting these signals of interest. This thesis first presents the processes of converting an analog signal to digital format and the major time division multiplexing standards employed throughout the world. It then introduces specific software tool kits that demodulate the intercepted signals and conduct bitstream analysis of the signals. Finally signals of interest are presented with step-by-step analysis on each specific signal.

INSTRUMENTING THE NAVAL POSTGRADUATE SCHOOL GLOBAL BROADCAST SERVICE TESTBED FACILITY
John A. Watkins-Lieutenant, United States Navy
B.A., University of San Diego, 1990
Master of Science in Information Technology Management-June 1997
Advisors: Paul H. Moose, Department of Electrical and Computer Engineering
Carl R. Jones, Department of Systems Management

The work reported in this thesis used readily available components to implement a data acquisition system for a Global Broadcast Service Testbed data collection facility. Use of hardware with controlling software is necessary to collect signal power content of satellite signals at a given distance from the transmitting source. Precise measurement and calibration of a satellite receive signal is accomplished by use of an Hewlett-Packard 8568B spectrum analyzer. A personal computer is used to collect and store retrieved data. These components are brought together using LabVIEW instrumentation software. This system provides an efficient means to collect signal data which can be used to verify satellite link performance estimates. Calculations are performed using Matlab statistical analysis software. This thesis contains calculated and measured values of total average carrier power and background noise levels for the three satellite receive systems that comprise the Naval Postgraduate School Global Broadcast Service Testbed facility.

ELECTROMAGNETIC IMAGING OF AXISYMMETRIC SCATTERERS
Daniel J. Wawrzyniak-Major, United States Marine Corps
B.E.E., Villanova University, 1986
Master of Science in Electrical Engineering-June 1997
Advisor: Michael A. Morgan, Department of Electrical and Computer Engineering
Second Reader: David C. Jenn, Department of Electrical and Computer Engineering

Radar cross-section is a key element of low-observability. In order to reduce the cross-section of a particular platform, it may be necessary to determine the induced source distribution on the platform which produces the scattered electromagnetic radiation. Determining the distribution may be possible using a probe to measure fields on or near the outer surface of the object. However, the act of measuring may indeed influence the currents being measured. An alternate method is to back-propagate measurements made at distances beyond the realm of strong influence on the parameters of interest to construct visualizations of the local on-surface radiation contributions. This has been demonstrated for the case of cylindrical geometry. The theory is extended in this thesis to axisymmetric bodies for the special case of rotationally symmetric fields.

ANALYSIS OF THE USE OF THE MACH-ZENDER COUPLER IN DEMODULATING MULTIPLEXED FIBER OPTIC SIGNALS

Paul W. Wehner-Lieutenant, United States Navy
B.S., United States Naval Academy, 1989
Master of Science in Electrical Engineering-September 1997
Advisor: Tri Ha, Department of Electrical and Computer Engineering
Second Reader: John P. Powers, Department of Electrical and Computer Engineering

Fiber optic communications are the future of U.S. Navy shipboard communications. They present tremendous bandwidths with no susceptibility to electro-magnetic interference (EMI) and outstanding signal-to-noise ratios. Current technology uses wavelength division multiplexing (WDM) to allow multiple users on a single fiber simultaneously. The optical filters necessary to demodulate the WDM signal can be expensive. A less costly alternative could be achieved if Hadamard-Walsh Code Shift Keyed (CSK) encoded signals were used. An optical receiver was proposed, using the Mach-Zender coupler, capable of demodulating a Hadamard-Walsh CSK encoded signal. Building on previous work studying the characteristics of the Mach-Zender coupler, a relationship between the probability of bit error and signal-to-noise ratio (SNR) was developed for a single user and a DPSK optical signal. This relationship was then used to develop an understanding of the bit-error rate to SNR relationship for a multiple-user CSK optical signal. Using the theoretical performance as a guide, a MATLAB model was then constructed to investigate the sensitivity of the receiver to non-ideal components.

AUTOMATIC EXTRACTION OF THREAT SIMULATOR CRITICAL PARAMETERS, VERSION 2.0 (U)

Martin J. Welch-Civilian
Master of Science in Electrical Engineering-June 1997
Advisor: Phillip E. Pace, Department of Electrical and Computer Engineering
Second Reader: David S. Woodson, III, Naval Research Laboratory

Anti-ship cruise missile (ASCM) threat simulator validation is a critical component of both the test and evaluation of shipborne electronic warfare (EW) systems and EW system operator training. The Navy unique ASCM simulator validation working group (SVWG) is responsible for evaluating the measured performance of these simulators with respect to their intended use. An important part of validation is comparing measured threat simulator radar parameters (or derived parameters based on the measured parameters) to the known or estimated parameters compiled in the Electronic Warfare Integrated Reprogramming (EWIR) database. The Naval Research Laboratory (NRL) conducts a battery of characterization tests on the various ASCM simulators using the NRL Central Target Simulator (CTS) to measure threat simulator seeker performance characteristics. The data collected during the characterization tests are used to compute threat simulator parameters that the SVWG can use to assess the simulator performance with respect to the EWIR database values. The AETSCP version 2.0 program automatically computes 44 threat simulator parameters, 35 of which are considered critical. This thesis documents the evaluation of the Automatic Extraction of Threat Simulator Critical Parameters (AETSCP) software version 1.2 and the resulting modifications, enhancements and additional capabilities incorporated into the AETSCP version 2.0.

TACTICAL UNMANNED AERIAL VEHICLES USED AS STAND-IN JAMMING PLATFORMS (U)

Anhtuan N. Wilson-Lieutenant, United States Navy
B.S., University of Colorado at Boulder, 1989
Master of Science in Systems Engineering-September 1997
Advisor: Curtis Schleher, Information Warfare Academic Group
Second Reader: Donald v. Z. Wadsworth, Department of Electrical and Computer Engineering

Electronic Attack plays an important role in support of Information Warfare. Electronic attacks on enemy radar systems limits their use of the electromagnetic spectrum for detection of in-coming aircraft, causing them to be incapable of defend-

ing their airspace during an attack. By taking advantage of modern technology and supporting military actions, the use of tactical Unmanned Aerial Vehicles (UAVs) as stand-in jammers extend the military's ability to suppress enemy radar systems. UAVs can be used to fly riskier missions than current electronic attack aircraft such as the EA6B because the loss of the vehicle has no potential for loss of human life. UAVs are feasible platforms for conducting stand-in jamming. By comparing various UAVs and decomposing a stand-in jamming mission into its operational and functional parts, the effectiveness of tactical UAVs to perform this mission is demonstrated. Matlab is used in conjunction with IMOM version 3.2 to compute the effectiveness of stand-in jamming against various radar systems.

LOW ALTITUDE OPTICAL SIGNAL PROPAGATION OVER THE OCEAN
Lean-Weng Yeoh, Ministry of Defence, Singapore
E.E., Naval Postgraduate School, 1990
Doctor of Philosophy in Electrical Engineering-March 1997
Dissertation Advisor: Hung-Mou Lee, Department of Electrical and Computer Engineering

The effects of ocean surface waves on optical signal fluctuations and optical refraction are evaluated. The effects on signal fluctuations were inferred from the ocean surface wave spectral density and temperature fluctuation spectral density. The effects of ocean waves on optical refraction are manifested in the near-surface gradient of the temperature profile. A modified temperature profile incorporating a statistical mixing length scale is proposed. The research points to the importance of certain parameters that should be considered when optical signals skim the ocean surface.

ELECTROMAGNETIC SCATTERING OF AN ANISOTROPICALLY COATED TUBULAR CYLINDER
Chen-Kuo Yu-Captain, Republic of China Navy
M.S.S.E., Naval Postgraduate School, 1990
Doctor of Philosophy in Electrical Engineering-March 1997
Advisor: Hung-Mou Lee, Department of Electrical and Computer Engineering

The sum-difference surface current formulation is introduced to treat electromagnetic boundary value problems when anisotropic impedances are specified on both sides of a surface. It can also be applied to impedance coated bodies. This formulation preserves the duality nature of Maxwell equations and carries it over into the algebraic form of the integrodifferential operators in the equations for surface currents. Since a 90° rotation is equivalent to undergoing a duality transform for an incident plane wave, this particular symmetry in the algebraic form of the operators leads to sufficient conditions under which the on-axis backscattering of an anisotropic impedance coated scatterer having a 90° rotational symmetry is eliminated. The sum-difference formulation is utilized for solving the problem of electromagnetic scattering from an anisotropically impedance coated tubular cylinder of finite length. The solution has been coded in FORTRAN and tested. Some interesting results are presented and discussed.